The Forge: A River in Distress

First Public Meeting

Forge River

Watershed Characterization

Presentation by
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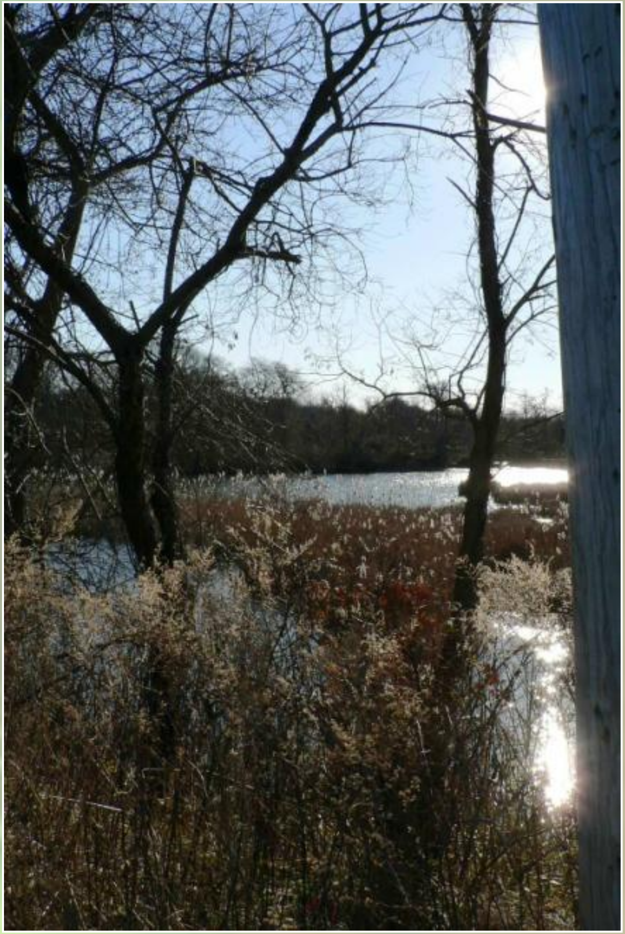
CH2M HILL

December 16, 2010

Watershed Characterization

- Upland Watershed
  - Geographic Setting
  - Delineations
  - Physical conditions
  - Land use
- River and Tributaries
  - Water quality
  - Sediments
  - Living resources
  - Key habitats
- Impairments & Threats to Water Quality



Geographic Setting

- Communities
  - All of Mastic, Moriches and Poospatuck
  - Portions of Shirley, Mastic Beach, Manorville and Center Moriches
- Forge River is tributary to Moriches Bay
- Major Highways
  - Interstate 495
  - State Hwy 27
- Long Island Rail Road
  - Montauk Branch
  - Ronkonkoma Branch

Geographic Setting

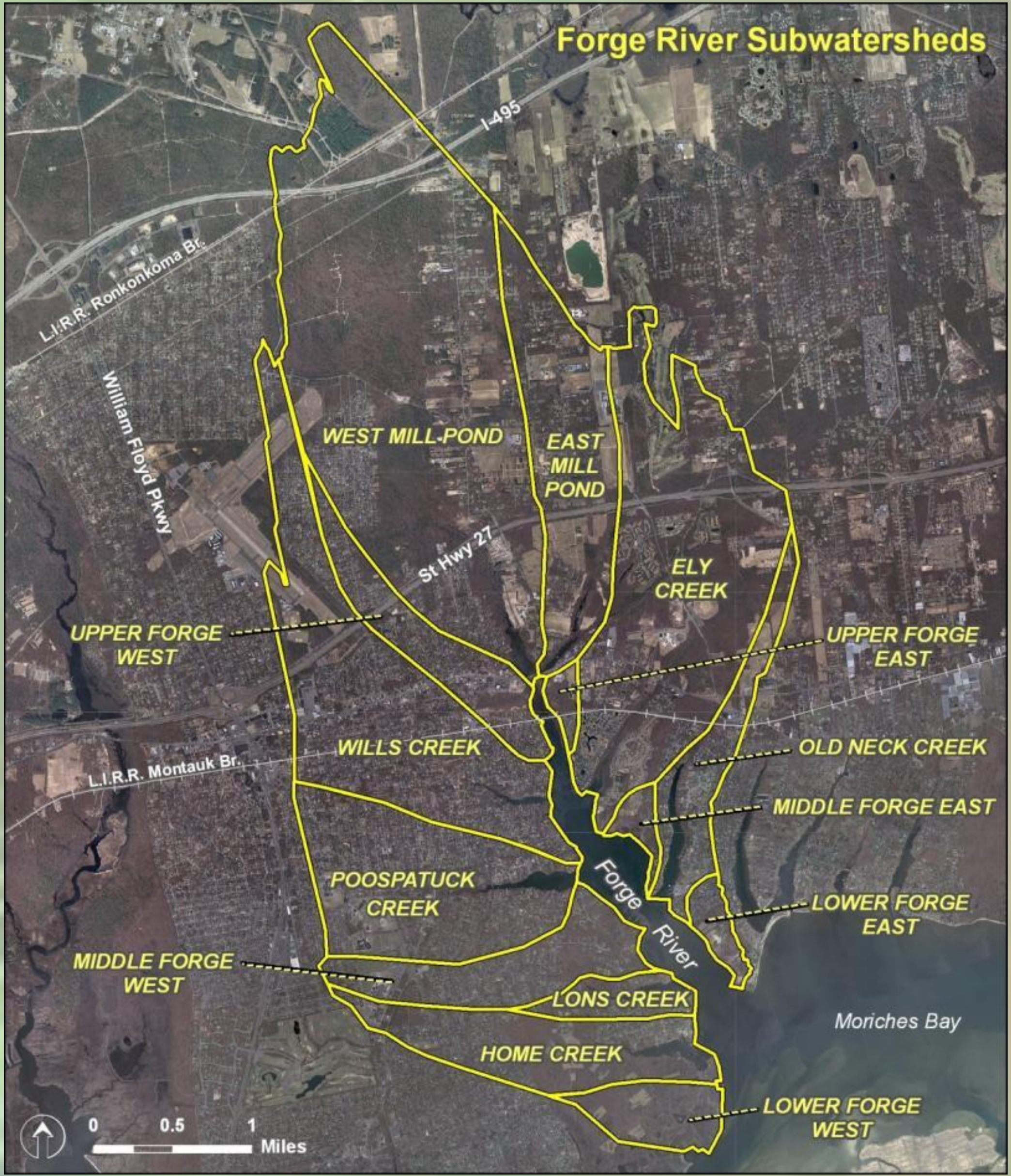
Surface Waters

Water Body	Area (Acres)	Percent of Total Area
Forge River	396.1	69.0%
Old Neck Creek	40.9	7.1%
Home Creek	29.4	5.1%
West Mill Pond	25.9	4.5%
Poospatuck Creek	25.5	4.4%
Small Ponds & Basins	23.4	4.1%
Lons Creek	15.2	2.6%
East Mill Pond	10.2	1.8%
Wills Creek	7.7	1.3%
Total	**574.3**	**100%**

Source: NYS DEC

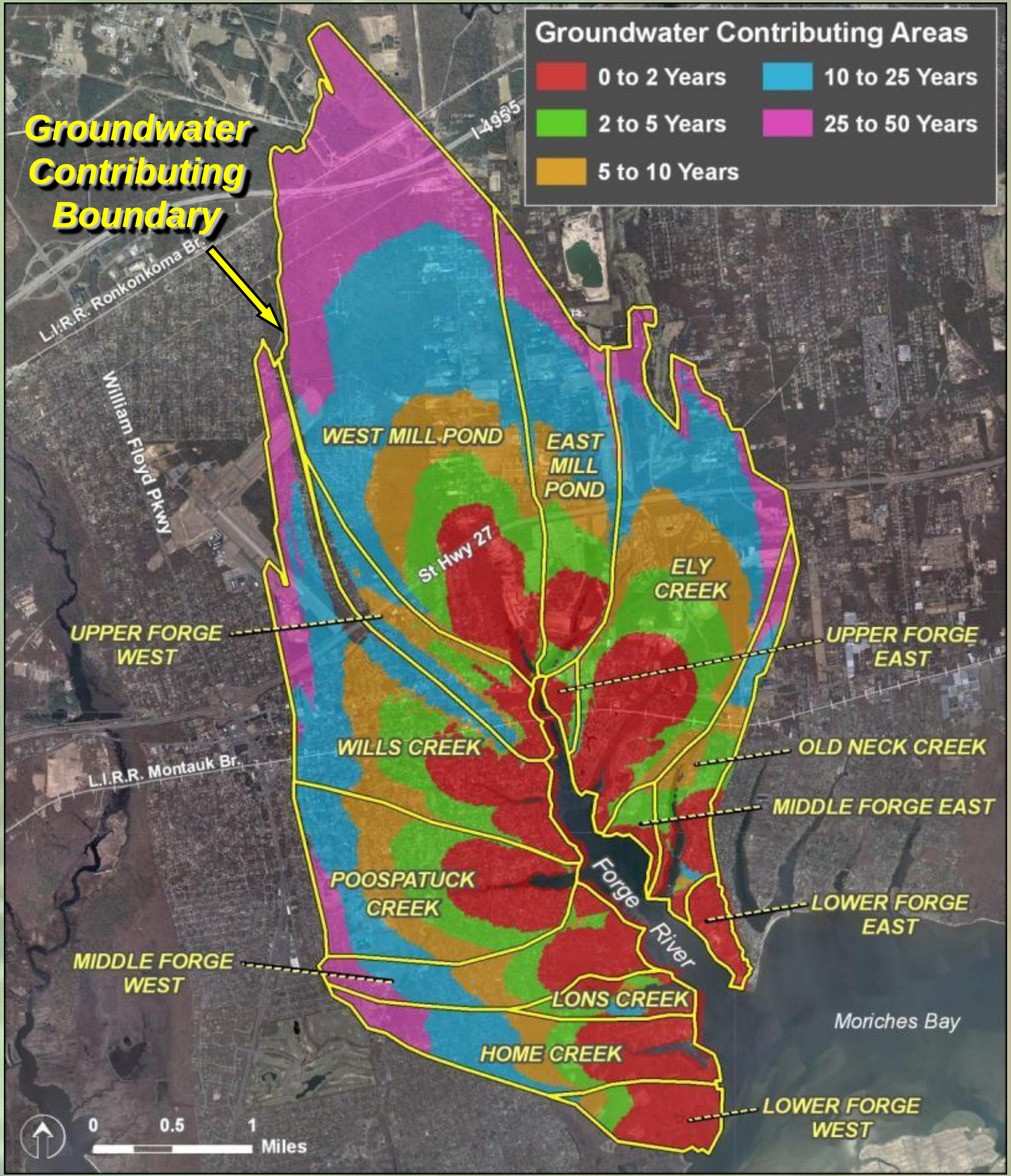
Watershed Delineation

- 14 Subwatersheds
  - West Mill Pond
  - East Mill Pond
  - Upper Forge West
  - Upper Forge East
  - Wills Creek
  - Ely Creek
  - Poospatuck Creek
  - Old Neck Creek
  - Lons Creek
  - Home Creek
  - Middle Forge West
  - Middle Forge East
  - Lower Forge West
  - Lower Forge East



Watershed Delineation

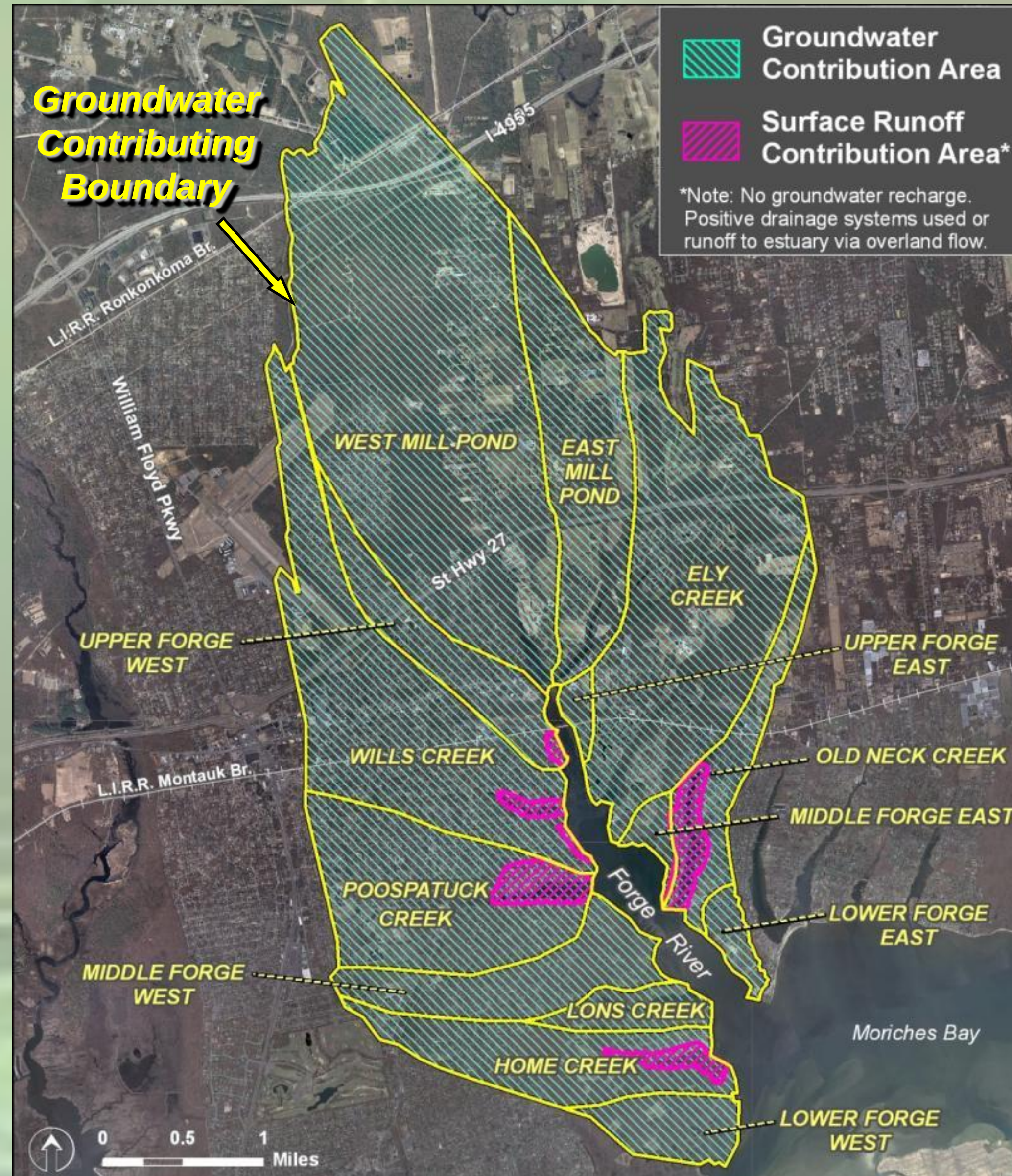
- Contributing Area Boundary
  - Stormwater is primarily directed to recharge basins inside the groundwater boundary



Source: Groundwater contributing boundary is from the Suffolk County Groundwater Model.

Watershed Delineation

- Contributing Area Boundary comprises
  - Groundwater contribution areas have:
    - Septic systems
    - Recharge basins
    - Leaching pools
  - Stormwater runoff to surface waters is limited to small areas adjacent to creeks

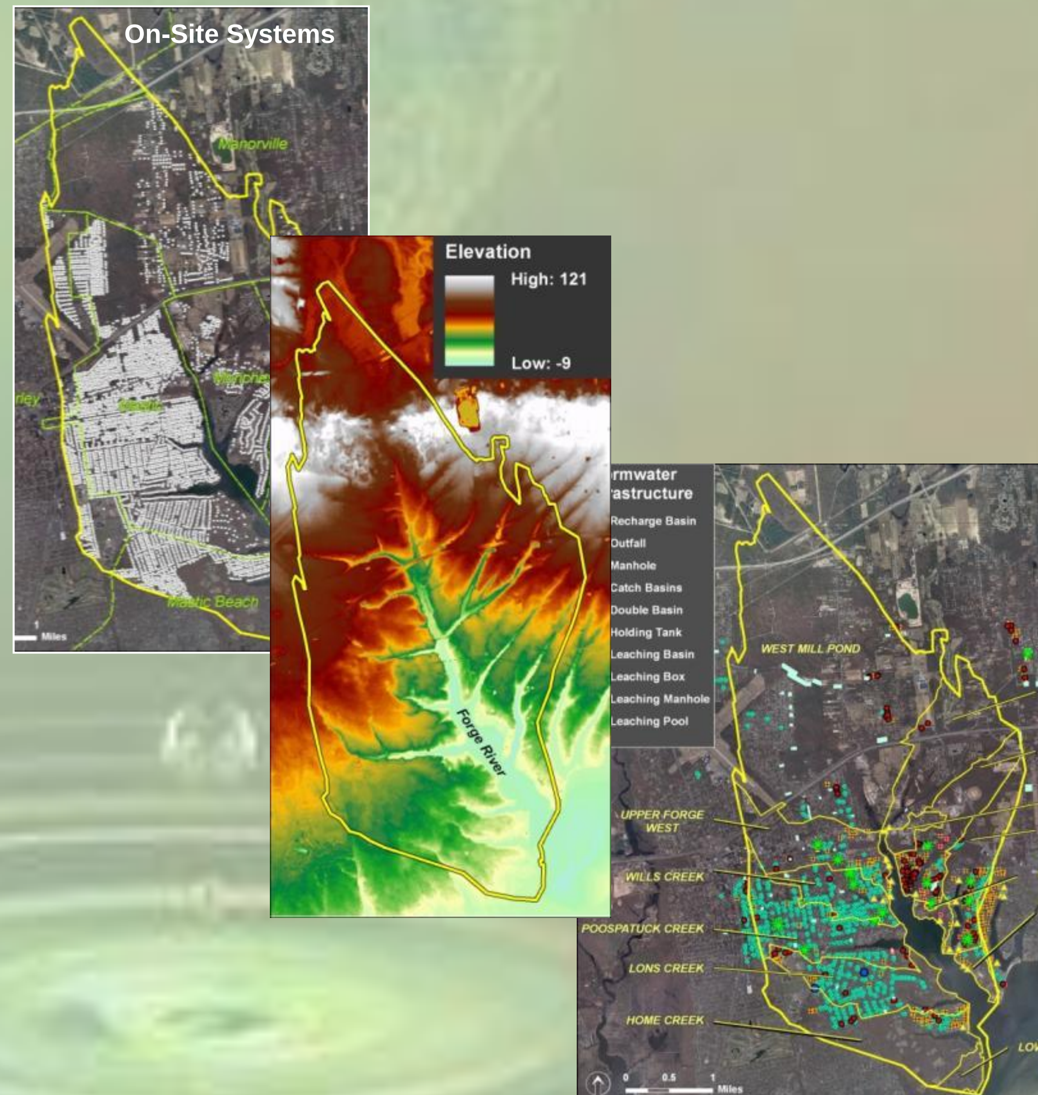


Watershed Delineations – Stream Flow

- West Pond is 72% of total freshwater streamflow from West and East Mill Ponds (SoMAS, 2007)
- 80% of stream flow to the Forge River is from the E. and W. Mill Ponds
- Pond flows measured by Redfield (1952) in 1947-1948 at 763,000 CF/D
- Pond flows measured by SoMAS in 2007 at 1.3 million CF/D
- Increase in flow could be new residential and commercial public water use since 1948, which is drawn from deep aquifers
- Groundwater flow is greater than streamflow: at a minimum, groundwater is 62% of total freshwater input to Forge River

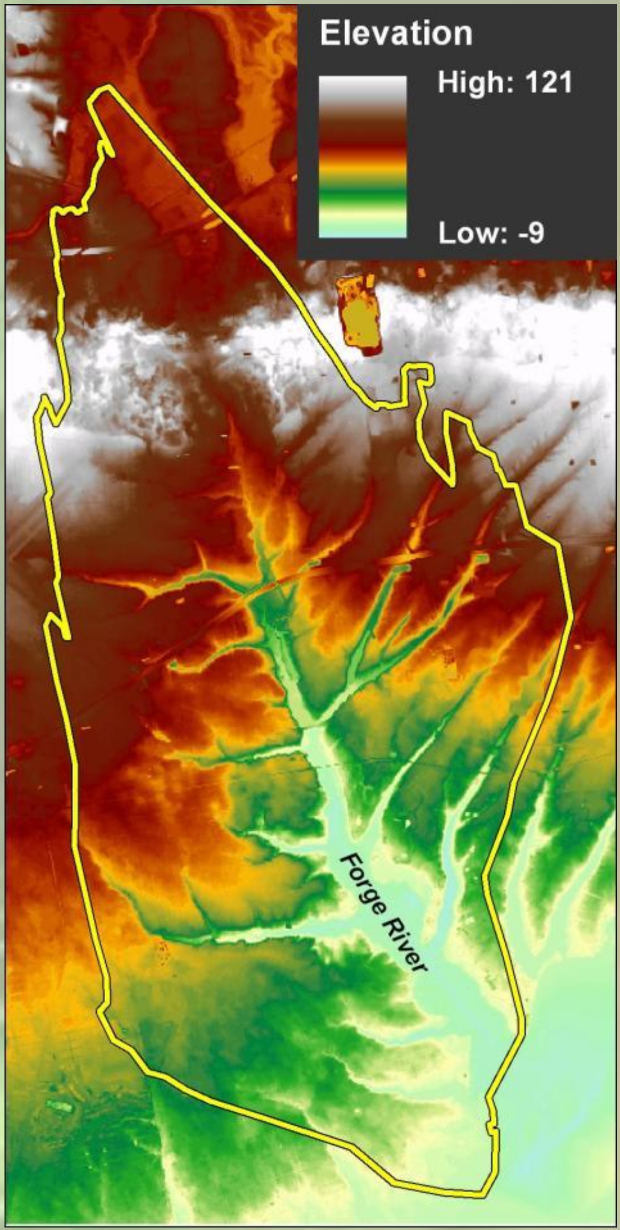
Physical Conditions

- Geography
  - Topography
  - Bathymetry
  - Groundwater
- Infrastructure
  - Stormwater
  - Wastewater



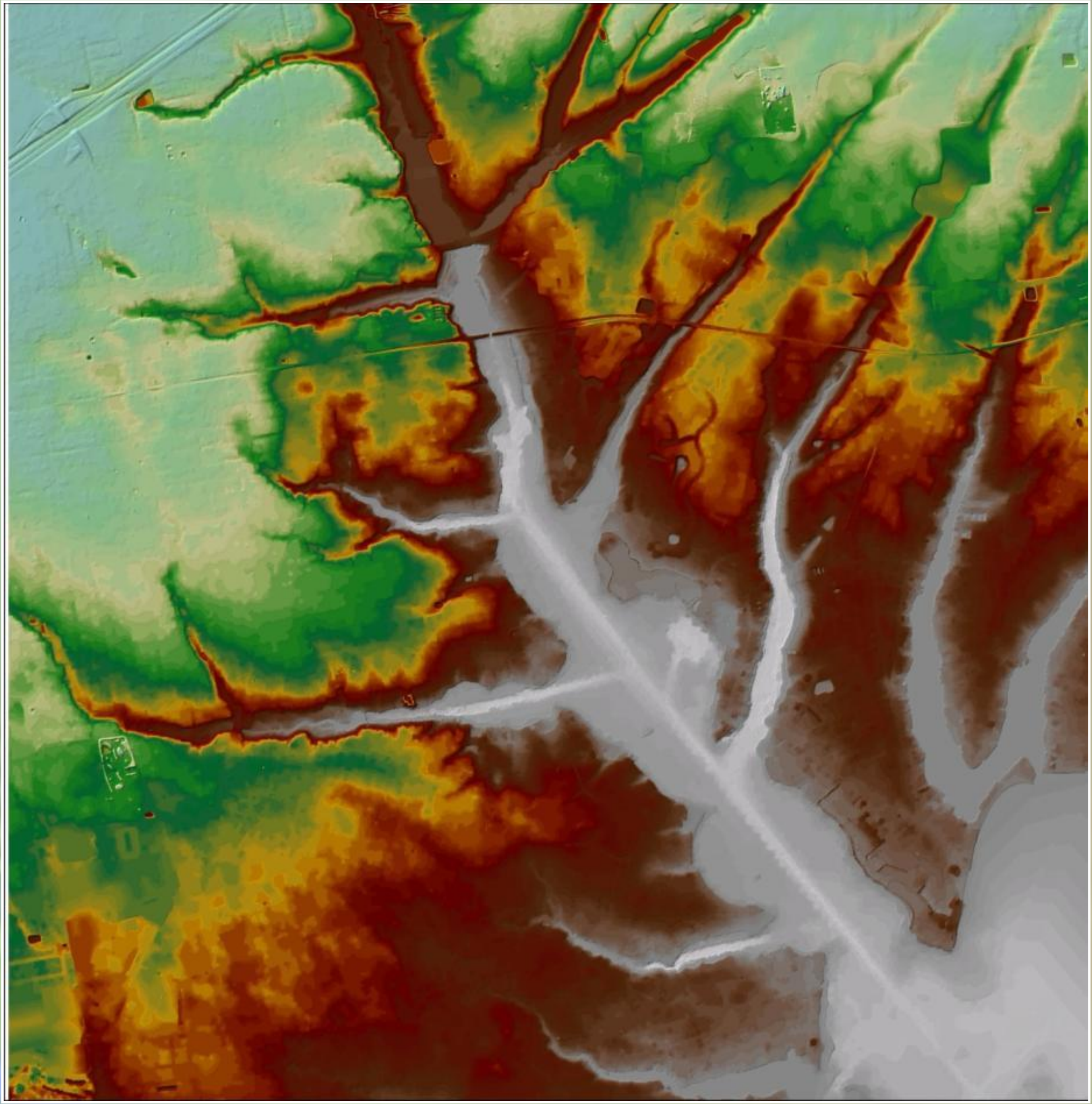
Topography & Bathymetry

- A composite model of topographic and bathymetric data was created
- Highest elevation at 121 feet
  Deepest channel elevation at -9 feet
- Gentle to moderate slopes between creeks
- Steep slopes near creek banks
- Creeks and stream beds form elongated cuts into landscape



Sources: Bathymetry provided by the Brookhaven GIS Department; LIDAR-based topography provided by the Suffolk County GIS Department.

Topography & Bathymetry

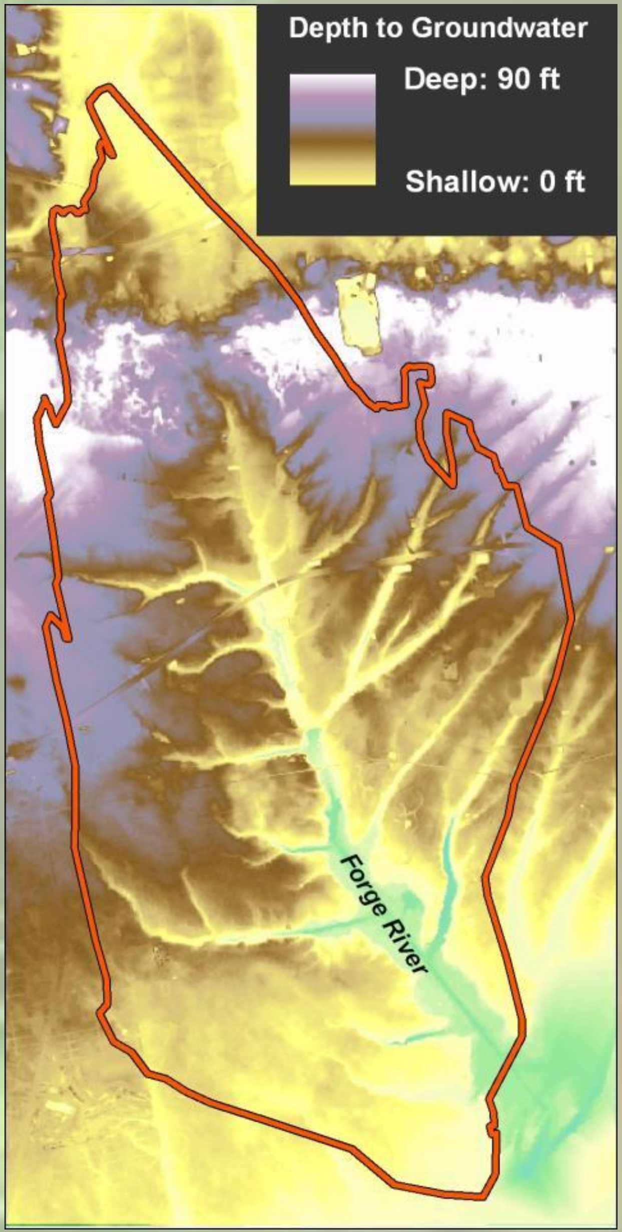


Bathymetric model provides high resolution representation of sills, channels and trenches

Sources: Bathymetry provided by the Brookhaven GIS Department; LIDAR-based topography provided by the Suffolk County GIS Department.

Depth to Groundwater

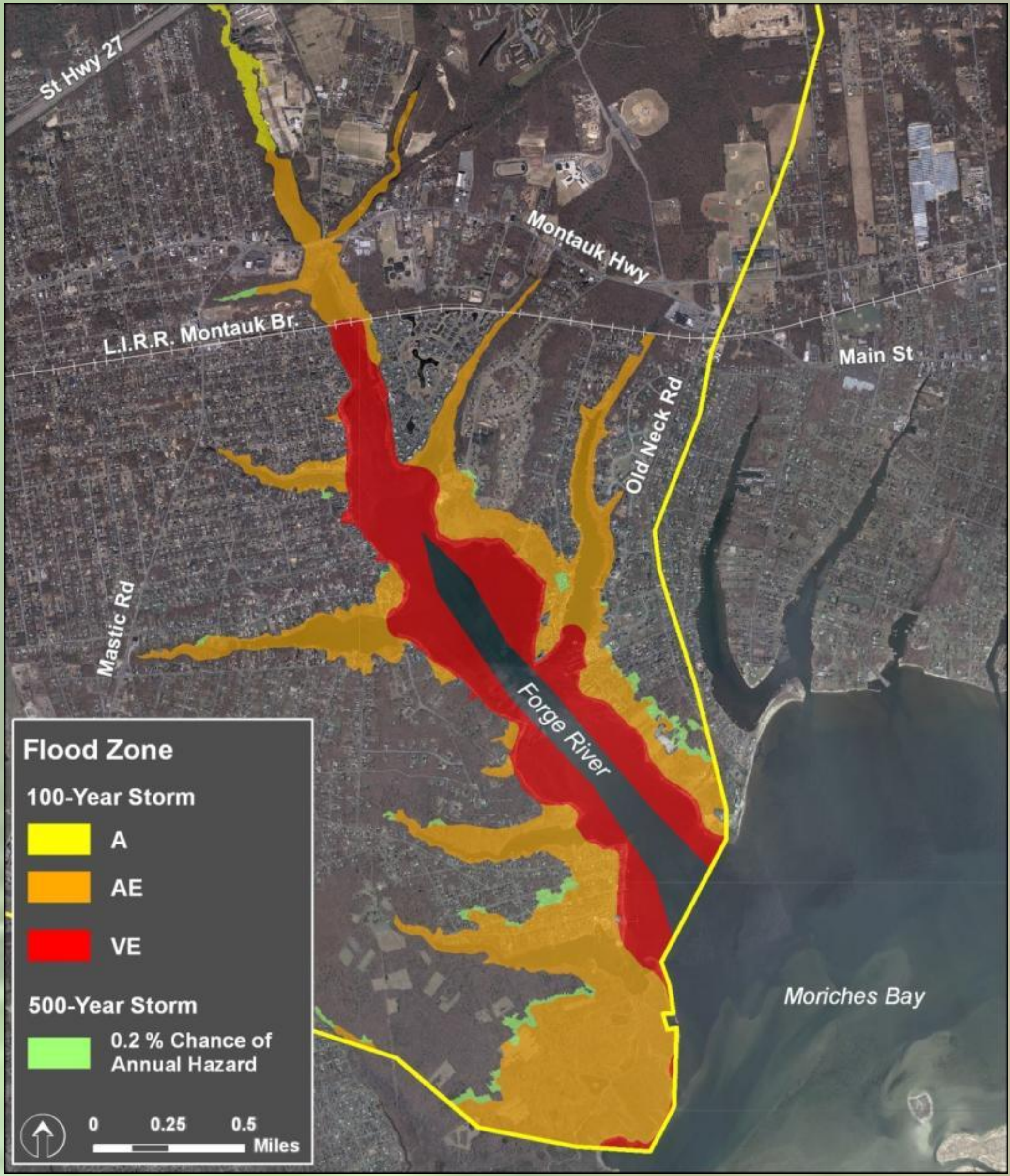
- Groundwater model is a combination of USGS groundwater elevations and the LIDAR-based topographic model
- Groundwater varies from a few feet below grade near shorelines to 90 feet deep in the upper watershed
- Used to determine the vertical separation of on-site wastewater treatment systems to groundwater



Sources: Groundwater elevations from United States Geological Survey. LIDAR-based topography provided by the Suffolk County GIS Department.

Flood Zones

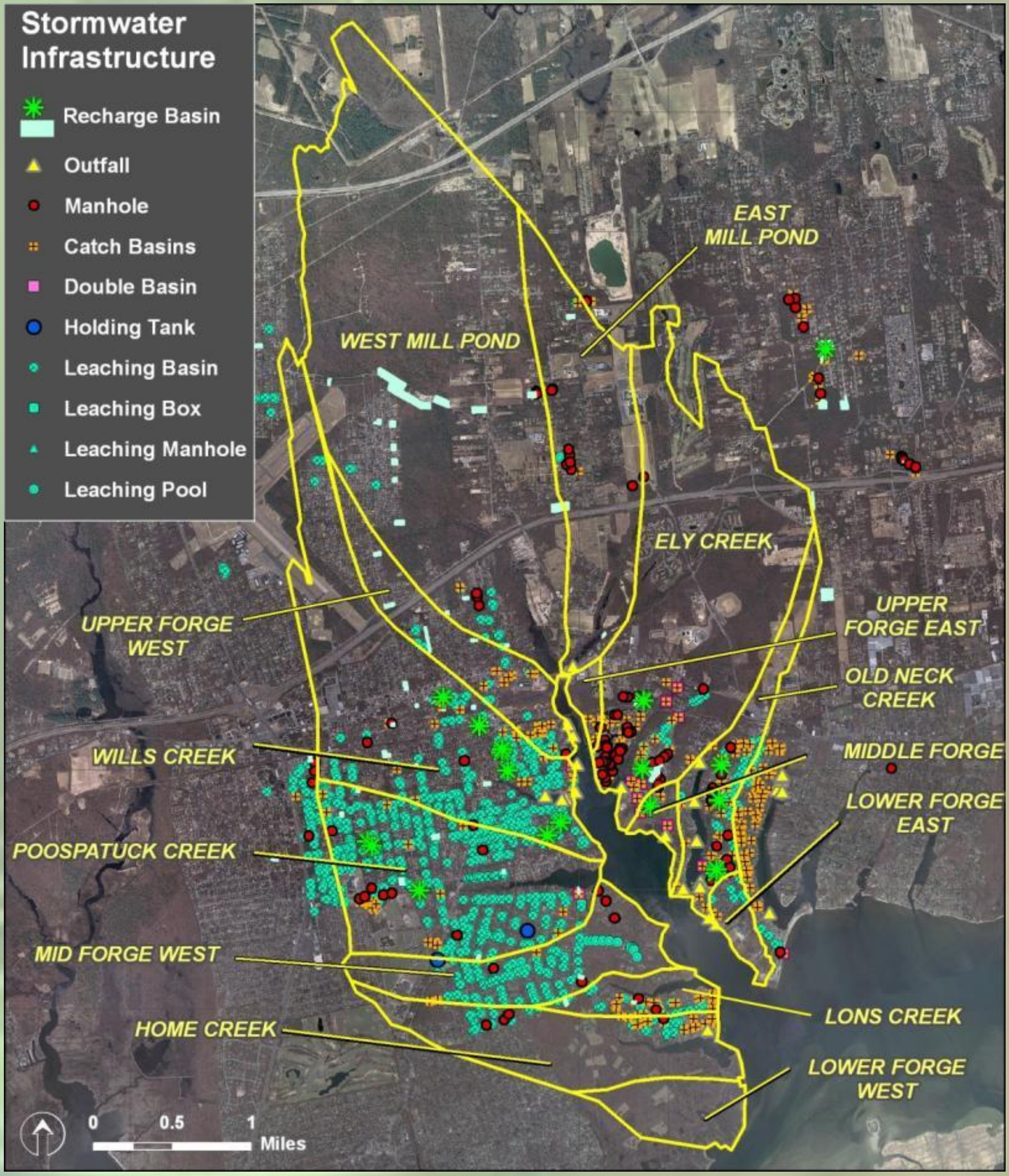
- Approximately 600 acres of the watershed are within the 100-year flood zone
- ~750 properties – mostly residential – are within the flood zone



Sources: DFIRM maps provided by FEMA.

Infrastructure – Stormwater

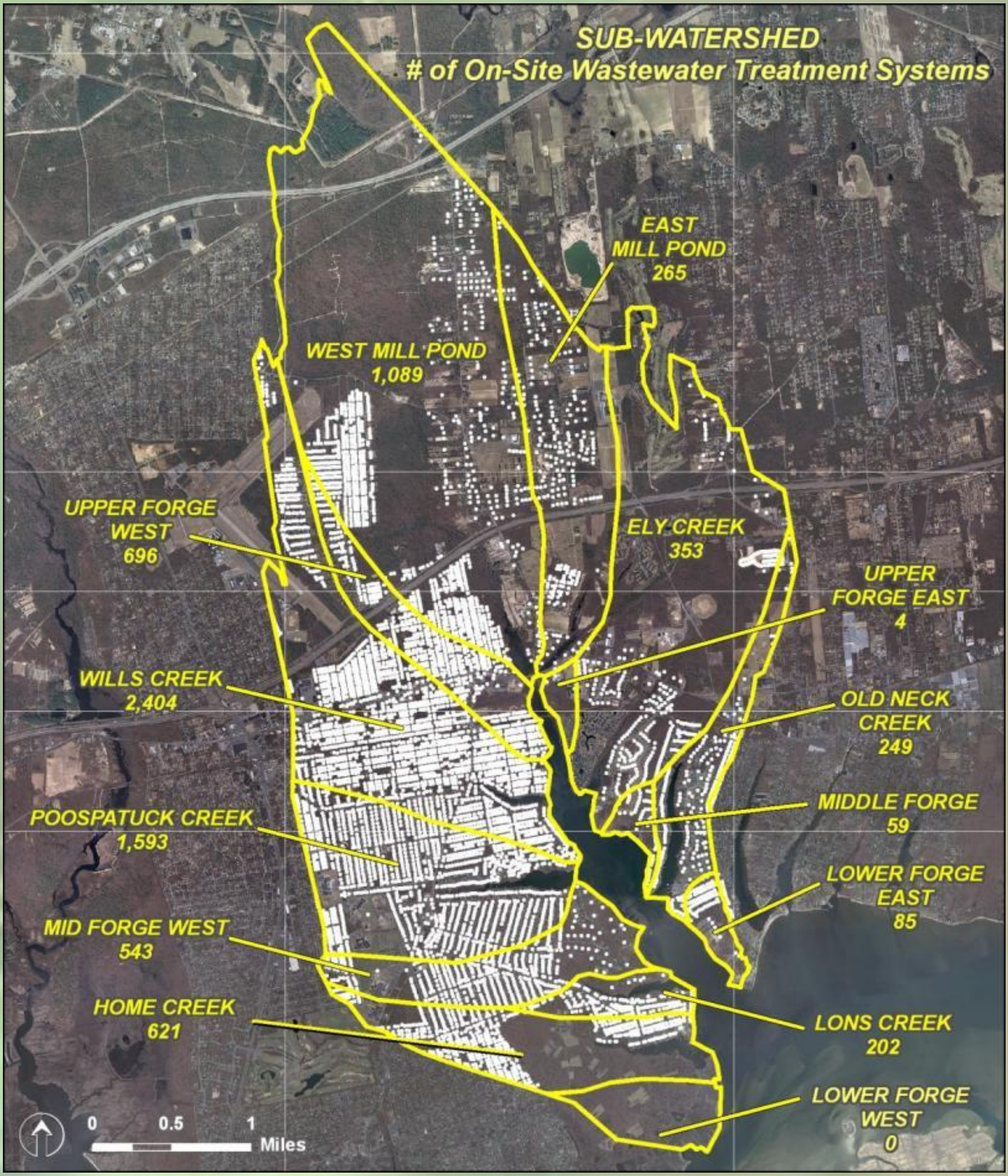
- Stormwater system is primarily constructed for groundwater recharge with:
  - Leaching basins/pools
  - Recharge basins that collect runoff from catch basins
  - Outfalls are usually for overflow from leaching basins
  - Limited positive drainage systems; only near shore



Sources: Infrastructure data from Brookhaven; field data collected by Cornell Cooperative Extension.

Infrastructure - Wastewater

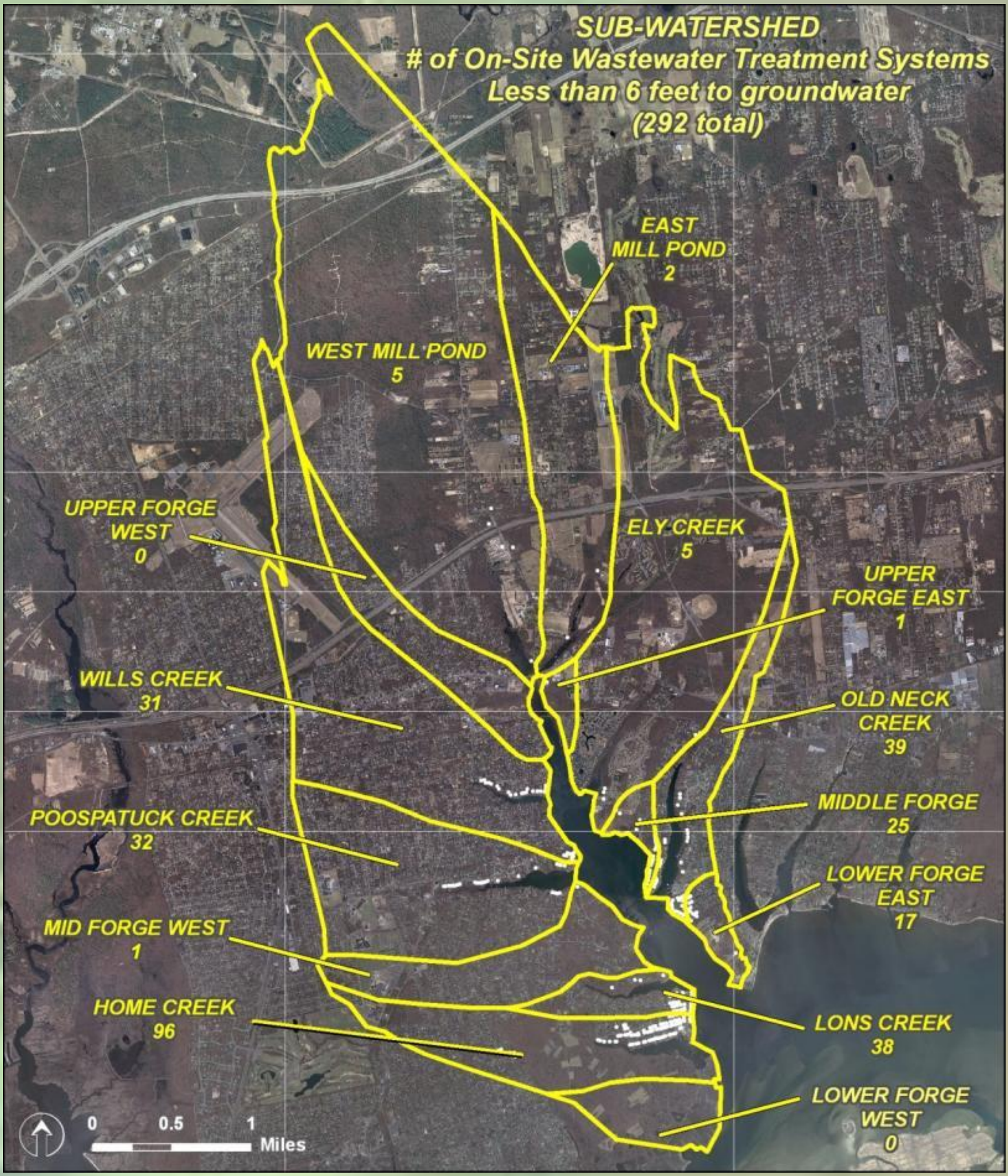
- ~8,200 on-site systems
- Mostly on small lots
- Majority within Mastic and Mastic Beach



Sources: Compilation of on-site systems based on GIS parcel data provided by Brookhaven GIS Department.

Infrastructure - Wastewater

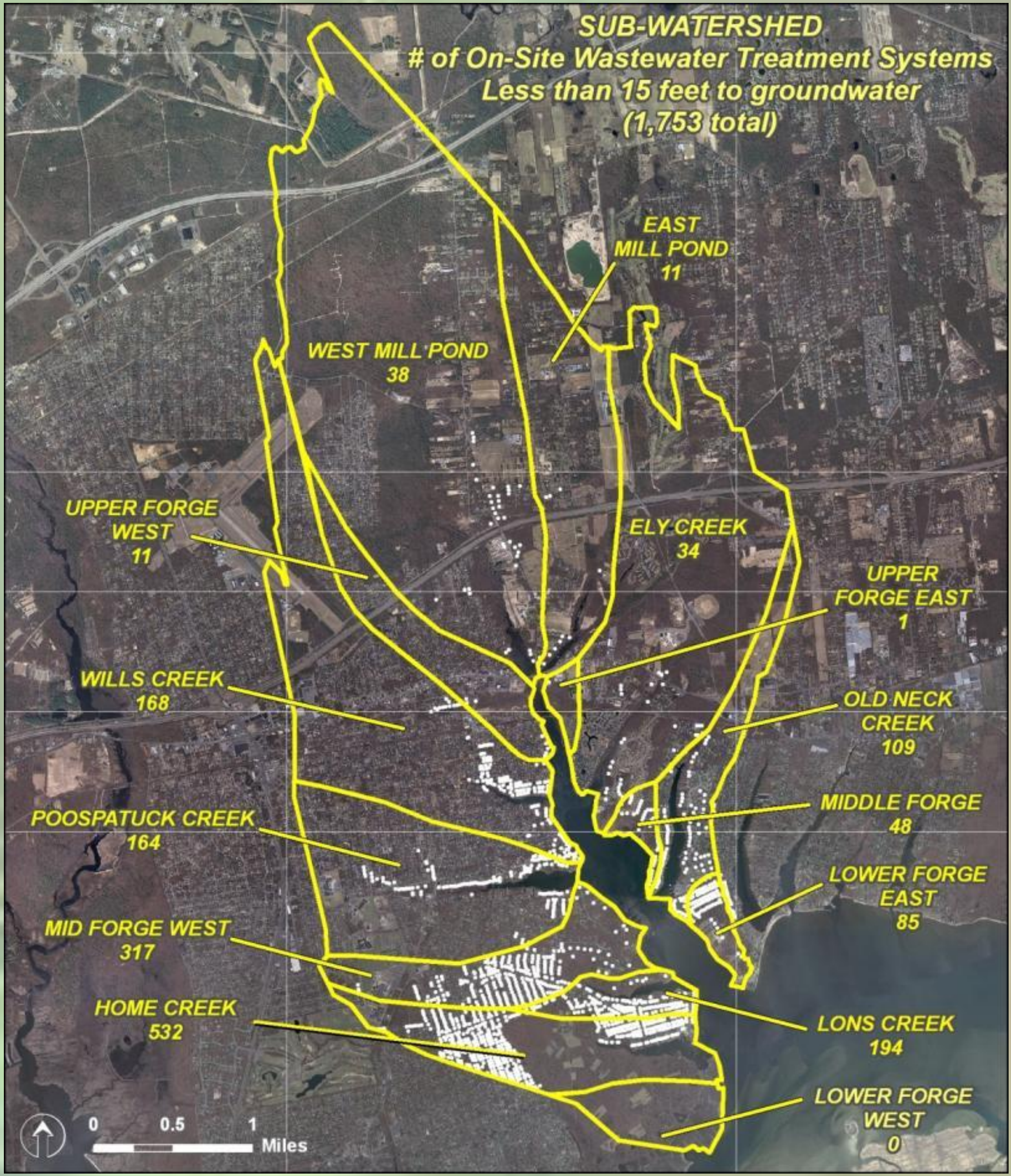
- On-site systems located in areas of shallow groundwater (less than 6 feet to groundwater)
- Often results in less than 2 feet of separation between system effluent and groundwater



Sources: Depth-to-groundwater model based on groundwater monitoring well data and maps from the United States Geological Survey.

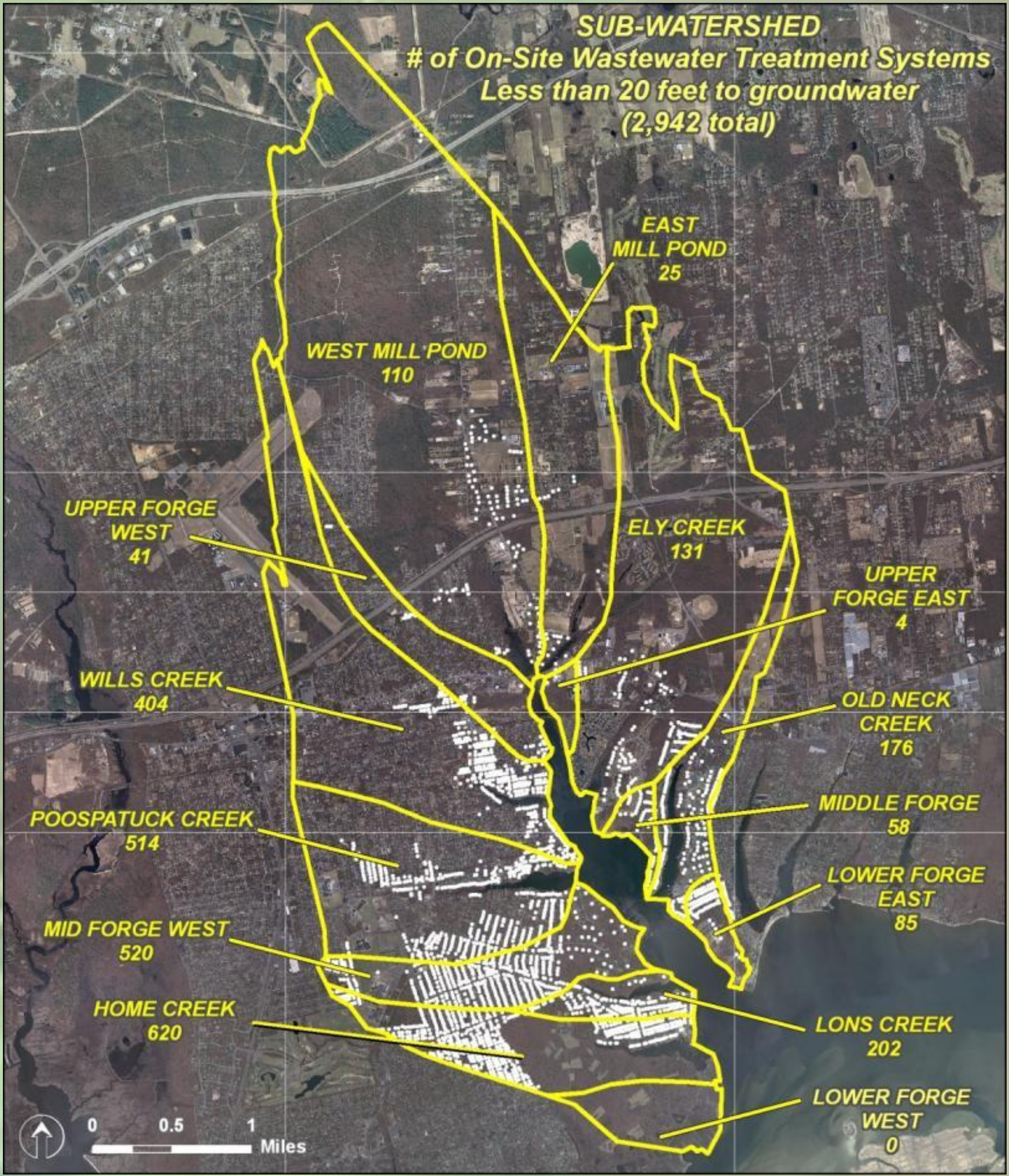
Infrastructure - Wastewater

- On-site systems located in areas where groundwater is 15 feet or less from surface



Infrastructure - Wastewater

- On-site systems located in areas where groundwater is 20 feet or less from surface



Infrastructure – Wastewater

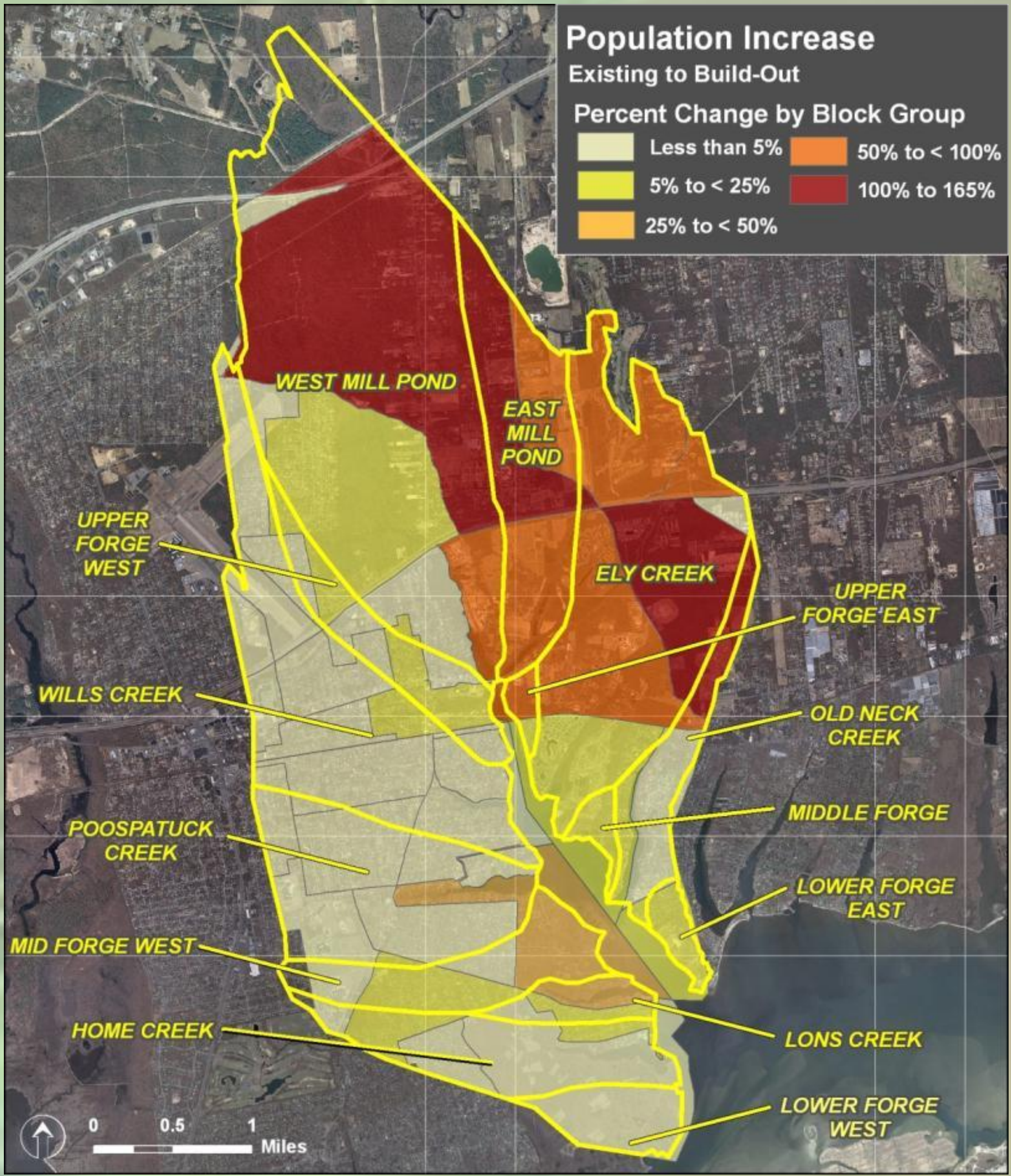
- 3 residential sewage treatment plants
- 2 duck farm treatment systems
    - one has exceedances of permit limits
    - the other is considered as a “no-discharge” as it has no outfall pipe, however discharge is to effectively shallow groundwater

Source: State Pollution Discharge Elimination System (SPDES) permit locations from the NY State Department of Environmental Conservation.

Demographics

- Mastic, Mastic Beach, Shirley, and Moriches
  - 1960: 14,592
  - 2005: 59,000
- Greatest growth (per decade) 1970-1980
- Study Area Population

- Current: 26,938
- Buildout: 31,725
- 17.7% increase



Sources: United States Census for historic data and Brookhaven GIS parcel data, Suffolk County Health regulations and Brookhaven zoning ordinance for build-out analysis..

Housing

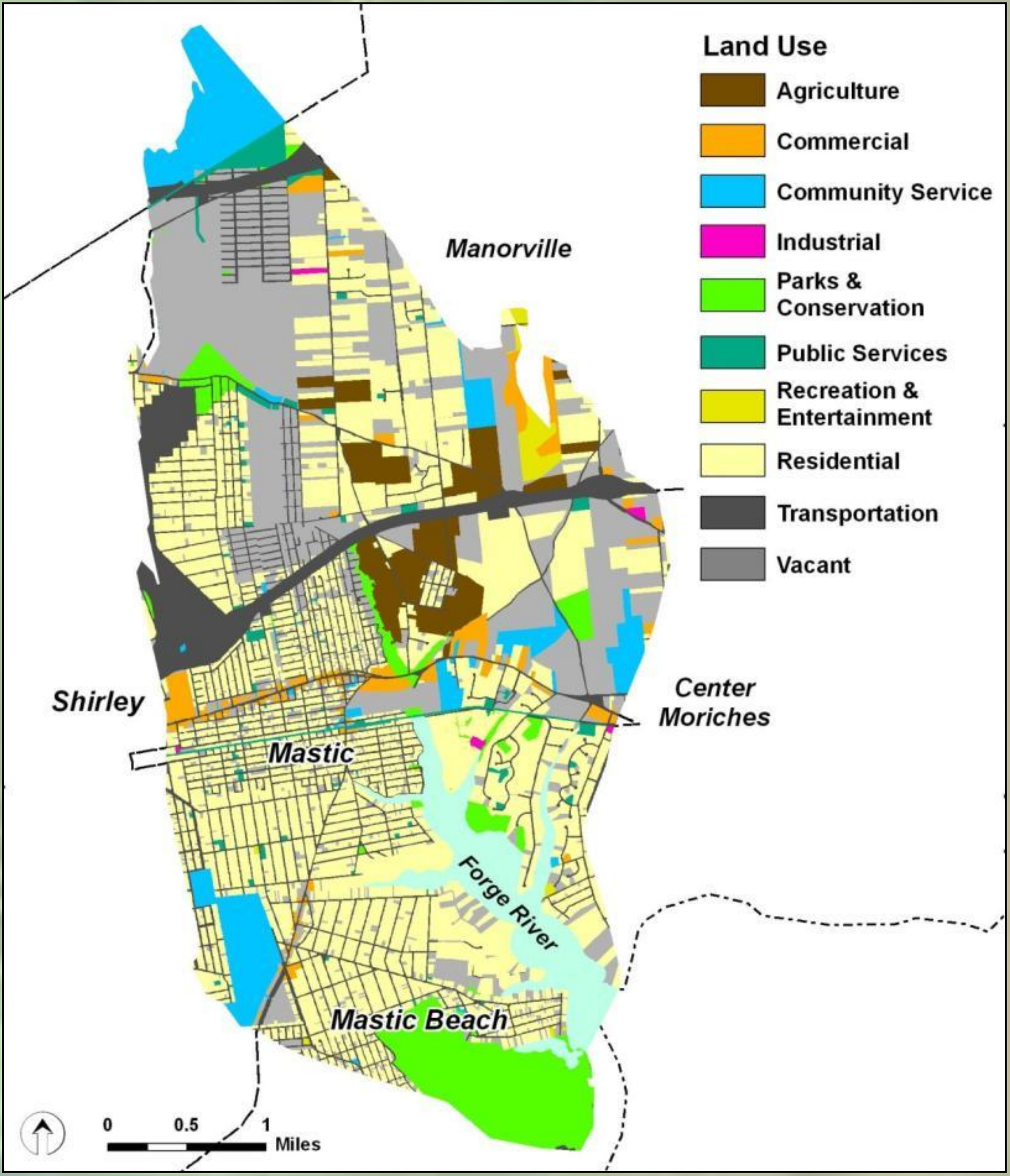
- Development of ‘Mastic Park’ began in the 1920’s
- ~8,200 homes inside the groundwater contributing area
- Age of housing stock
  - Pre 1970 (cesspools): 3,261
  - 1970-1980 (cesspools and septic systems): 2,911
  - 1980-2000 (septic systems): 2,978
  - 2000-2010 (septic systems): census data not yet available
- Conversion to public water added substantial groundwater flow

Source: United States Census for historic data on housing stock.

Land Uses – Existing

Land Use Class	Acreage	Percent
Agriculture	396.5	4.2%
Commercial	239.3	2.5%
Community Service	591.3	6.2%
Industrial	14.2	0.1%
Parks & Conservation	653.3	6.9%
Public Services	148.7	1.6%
Recreation & Entertainment	61.8	0.7%
Residential	3,677.4	38.8%
Transportation	1,430.6	15.1%
Vacant	2,267.5	23.9%
Total	**9,480.6**	100.0%

Source: Brookhaven GIS Department with field verification of land uses by project team.



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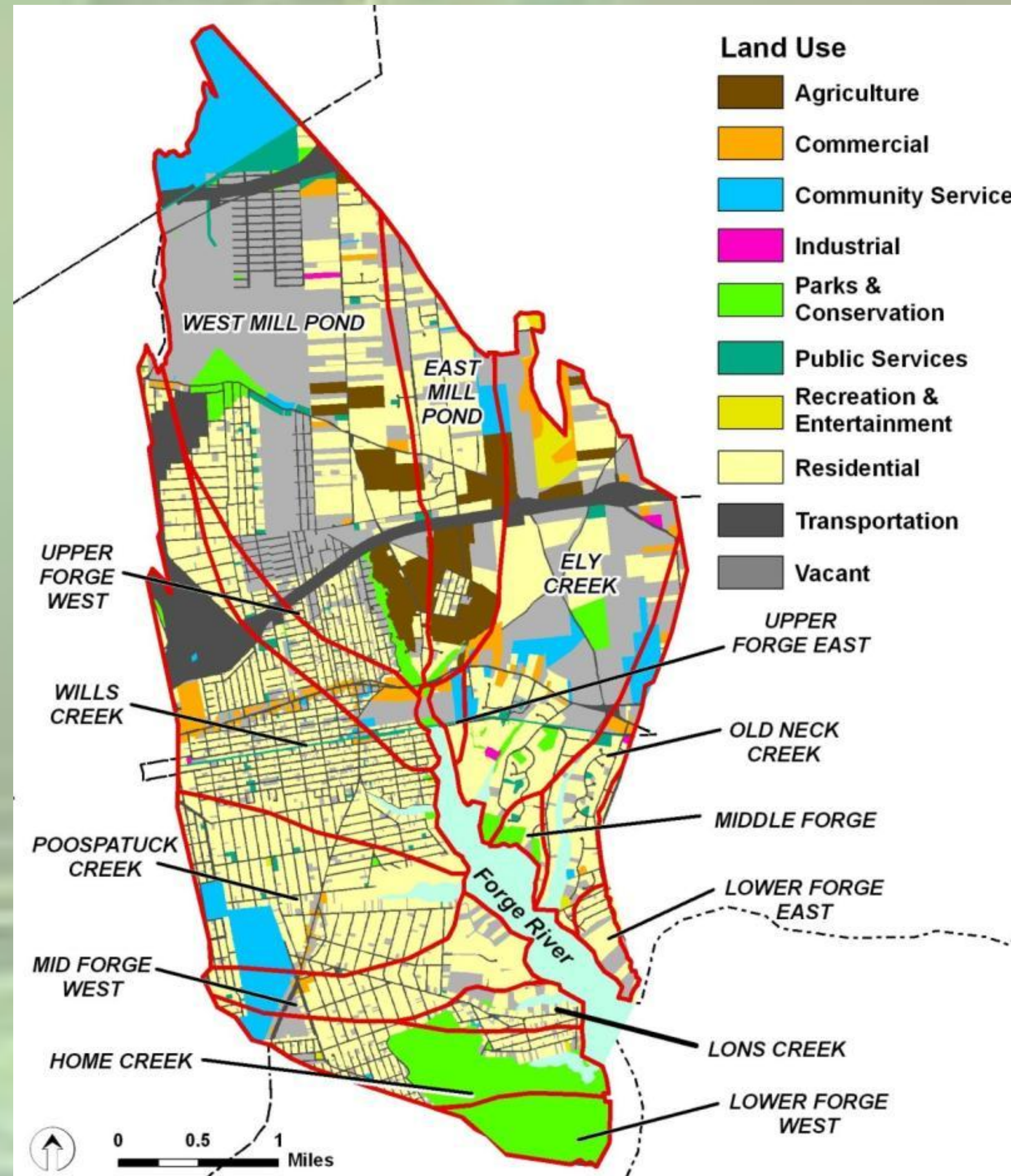


Land Uses – Duck Farms

- Began in 1880’s, peaked in 1960’s
- Ten ‘ranches’ in FR watershed
  - North of West Pond
  - Both sides East Pond
  - Swift Creek south of Montauk, west side of FR
  - Ely Creek north shore
  - Old Neck Creek south shore
- Eight ranches in 1964, 50,000-150,000 ducks/ranch-year
- Two ranches by 1982; north of Mill Ponds
- Duck sludge estimated (US Dept. of the Interior, 1968) at 5.2 M CY in tidal FR, including Ely and Old Neck Creeks

Nitrogen Inputs – Duck Farms

Jurgielewicz Duck Farm

Subwatershed Nitrogen Input Summary

Existing Nitrogen Contributions (lbs/day)

Lower Forge West	1.73
Home Creek	137.61
Lons Creek	75.18
Middle Forge West	49.05
Poospatuck Creek	164.01

Wills Creek	173.20
Upper Forge West	41.82
West Mill Pond	301.25
East Mill Pond	41.83
Upper Forge East	3.59

Ely Creek	97.57
Middle Forge East	3.83
Old Neck Creek	148.31
Lower Forge East	5.55

Build-Out Nitrogen Contributions (lbs/day)

Lower Forge West	1.82
Home Creek	140.05
Lons Creek	76.03
Middle Forge West	52.44
Poospatuck Creek	169.32

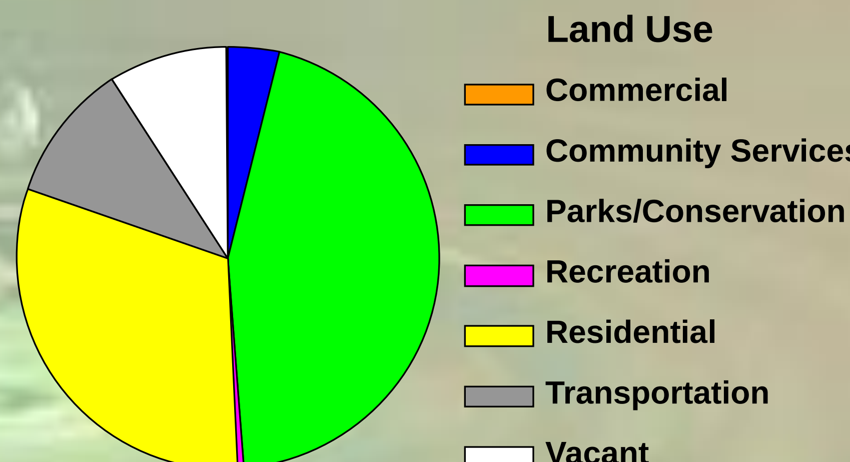
Wills Creek	176.42
Upper Forge West	45.38
West Mill Pond	397.68
East Mill Pond	58.53
Upper Forge East	3.78

Ely Creek	131.60
Middle Forge East	3.97
Old Neck Creek	153.00
Lower Forge East	7.18

Subwatershed Summary – Home Creek

Nitrogen Contributions (lb/day)		
Input	**Existing**	**Build-out**
Fertilizer	2.87	3.16
Atmospheric	4.56	4.56
On-Site Wastewater	29.40	31.56
WWTP Effluents	0.00	0.00
Benthic Flux*	100.77	100.77
Total	**137.61**	**140.05**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS



- 621 On-Site Wastewater Treatment Systems
- Residential and Conservation Uses are dominant

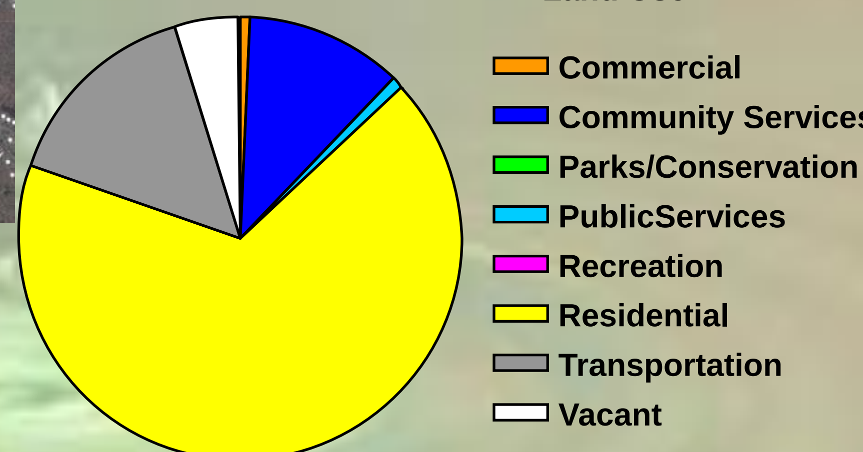
Subwatershed Summary – Poospatuck Creek

Nitrogen Contributions (lb/day)		
Inputs	**Existing**	**Build-out**
Fertilizer	10.58	10.65
Atmospheric	6.61	6.61
On-Site Wastewater	79.20	84.45
WWTP Effluents	0.00	0.00
Benthic Flux	67.62	67.62
Total	**164.01**	**169.32**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS

- 1,593 On-Site Wastewater Treatment Systems
- Residential is majority of land use
- Community Services and Vacant Land are secondary

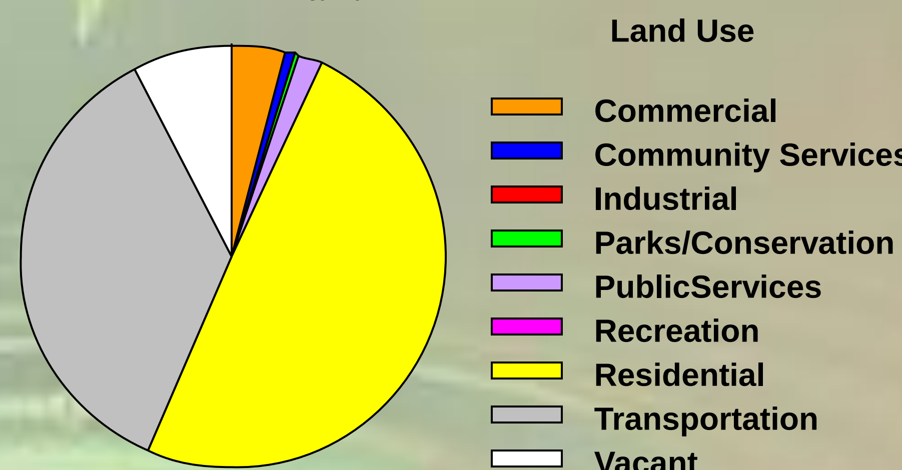
Land Use



Subwatershed Summary – Wills Creek

Nitrogen Contributions (lb/day)		
Inputs	**Existing**	**Build-out**
Fertilizer	10.04	10.08
Atmospheric	10.06	10.06
On-Site Wastewater	127.01	130.19
WWTP Effluents	0.00	0.00
Benthic Flux	26.09	26.09
Total	**173.20**	**176.42**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS



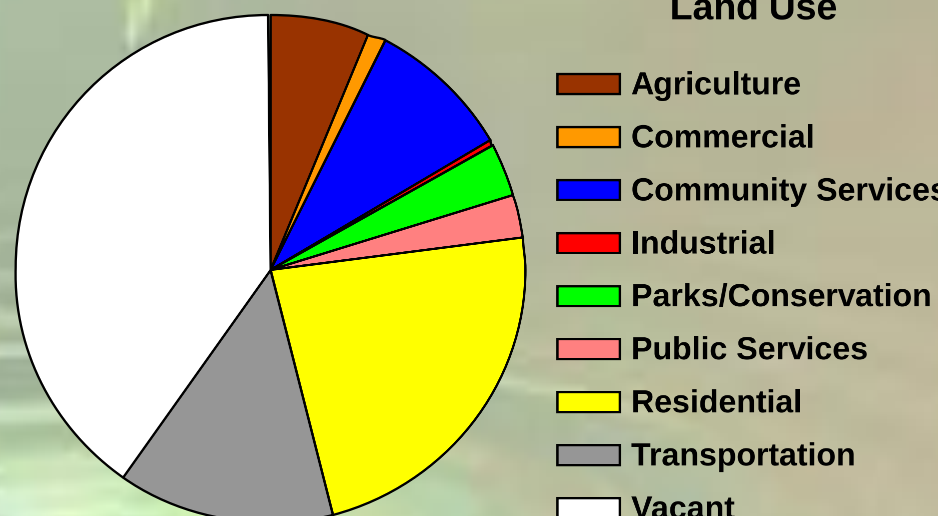
- 2,404 On-Site Wastewater Treatment Systems
- Residential is majority of land use
- Transportation (Airport) is second largest use

Subwatershed Summary – West Mill Pond

Nitrogen Contributions (lb/day)		
Inputs	**Existing**	**Build-out**
Fertilizer	14.73	19.99
Atmospheric	23.17	23.17
On-Site Wastewater	52.86	144.02
WWTP Effluents	195.00	195.00
Benthic Flux	15.49	15.49
Total	**301.25**	**397.68**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS

Land Use

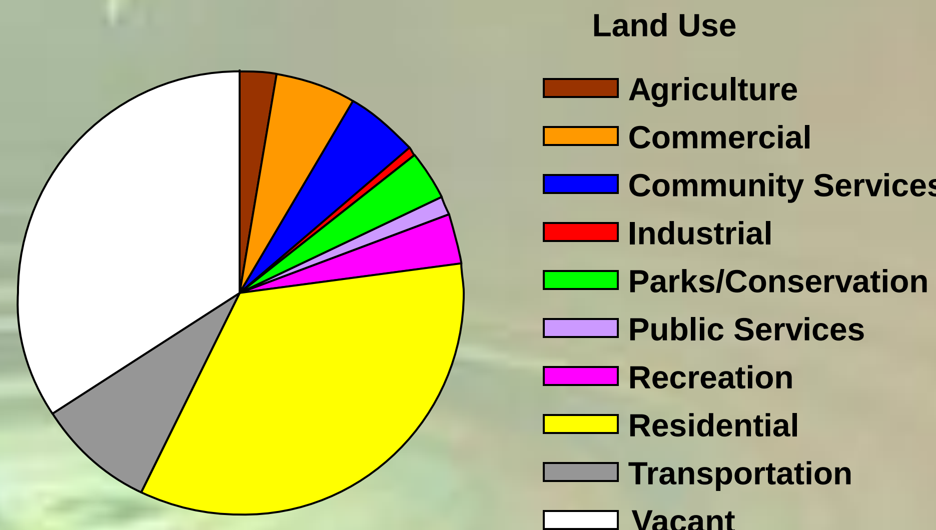


- 1,089 On-Site Wastewater Treatment Systems
- Highest Nitrogen Input of all subwatersheds

Subwatershed Summary – Ely Creek

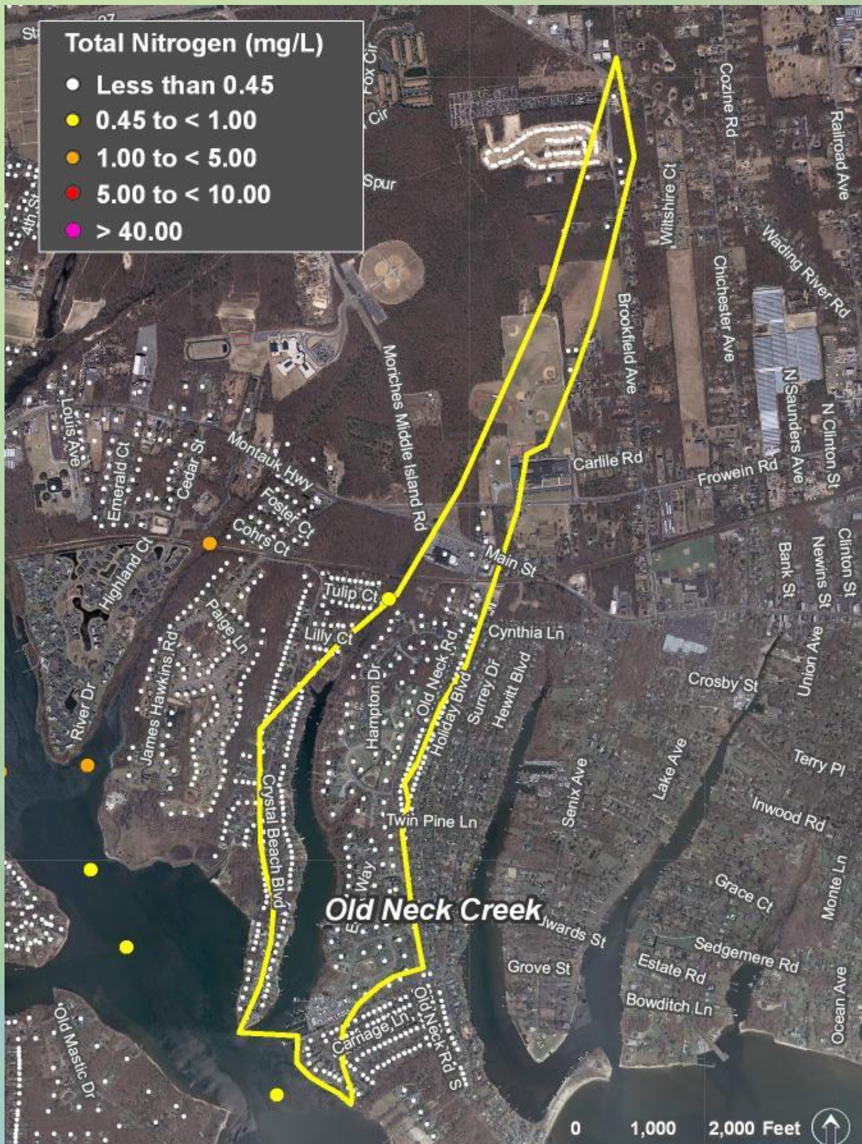
Nitrogen Contributions (lb/day)		
Inputs	**Existing**	**Build-out**
Fertilizer	11.84	18.41
Atmospheric	12.81	12.81
On-Site Wastewater	19.64	47.10
WWTP Effluents	24.55	24.55
Benthic Flux	28.74	28.74
Total	**97.57**	**131.60**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS



- 353 On-Site Wastewater Treatment Systems
- 3 Sewage Treatment Plants

Subwatershed Summary – Old Neck Creek

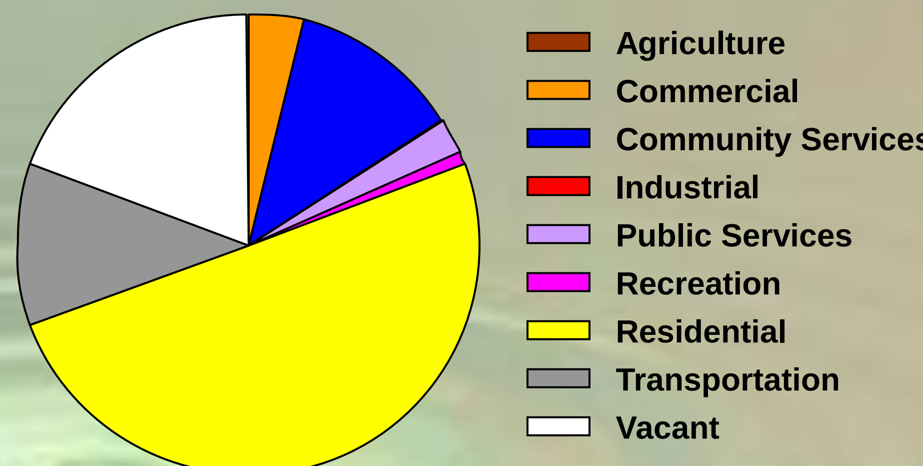


Nitrogen Contributions (lb/day)

Inputs	Existing	Build-out
Fertilizer	2.91	4.01
Atmospheric	2.60	2.60
On-Site Wastewater	13.83	17.42
WWTP Effluents	0.00	0.00
Benthic Flux	128.98	128.98
Total	**148.31**	**153.00**

Source: Project team estimates and
Benthic flux methodology by *SUNY SOMAS

Land Use



- 249 On-Site Wastewater Treatment Systems
- 50 percent of land in residential use

Tidal Circulation

- Pre-dredging Bathymetry
- Dredging and Channels
- Moriches Inlet
- Circulation

Source: Except where indicated, data from Wilson et.al. (2009)and Swanson et.al. (2009)

Natural Bathymetry

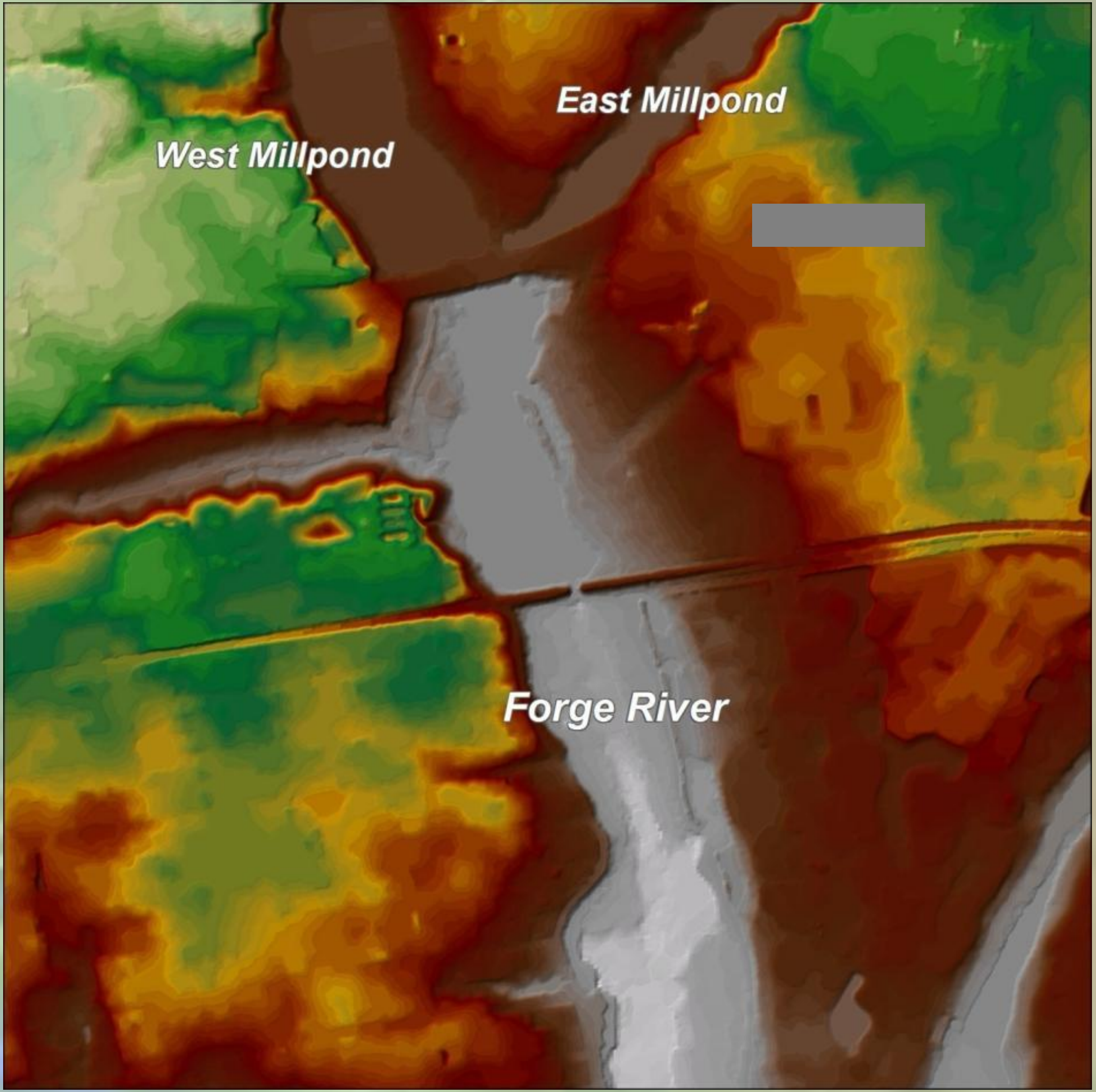
- Naturally shallow estuary
  - 1933 survey (prior to dredging)
    - Lons Creek to Ely Creek – 4 feet at MLW
    - Wills Creek to Waterways marina – 2-3 feet at MLW
    - Brookhaven Town dock – 3 feet at MLW
    - North of Waterways to RR bridge – 1-2 feet at MLW

Bathymetry Post - Dredging

- First dredging in 1965, main channel only
  - 265,9000 CY removed for main channel and pollution control
  - Channel 100 feet wide, 7 feet deep
- Creeks dredged 1967-1973 (depths: 6-8 feet)
- Intercoastal Waterway (1940)
  - Extends from Patchogue to Shinnecock Canal
  - Width of 100 feet, depth of 6 feet
- Mouth of FR to Intercoastal Waterway dredged 1999
- Channel (East-West Moriches) dredged 2002-2003
  - About 80,000 CY; spoil to East Inlet Island

Topography & Bathymetry

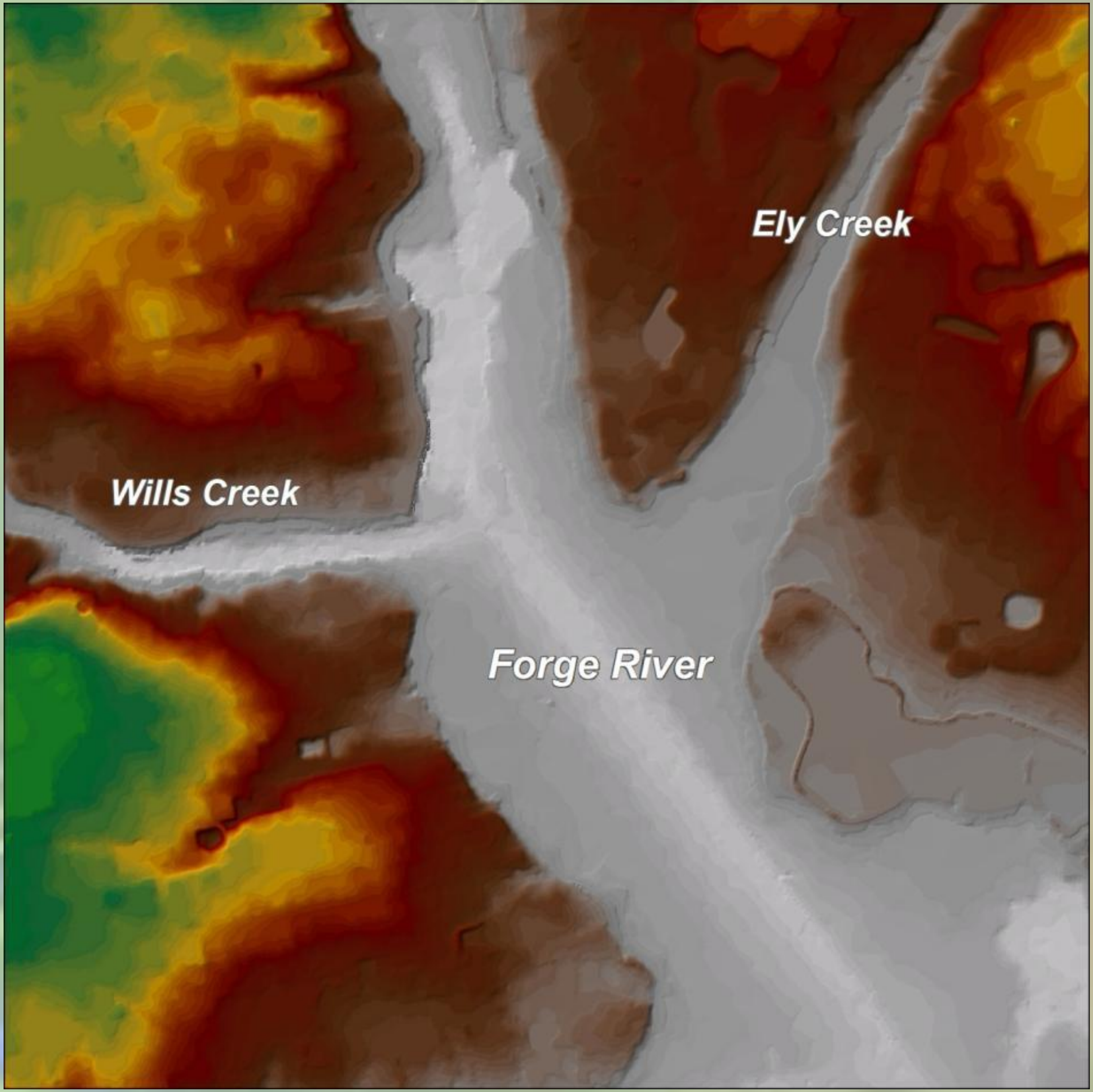
Upper Forge River



Sources: Bathymetry provided by the Brookhaven GIS Department; LIDAR-based topography provided by the Suffolk County GIS Department.

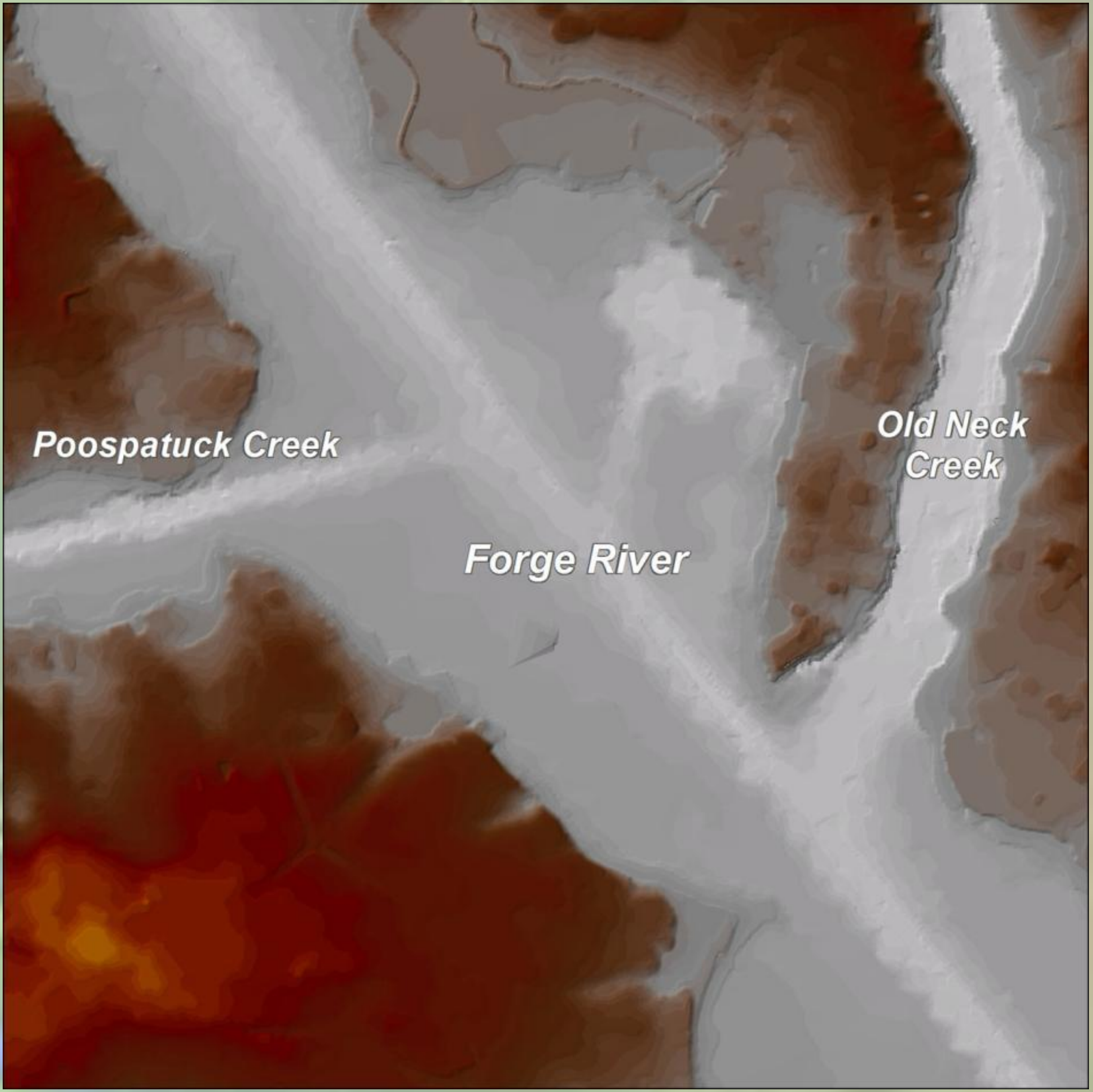
Topography & Bathymetry

Upper - Middle
Forge River



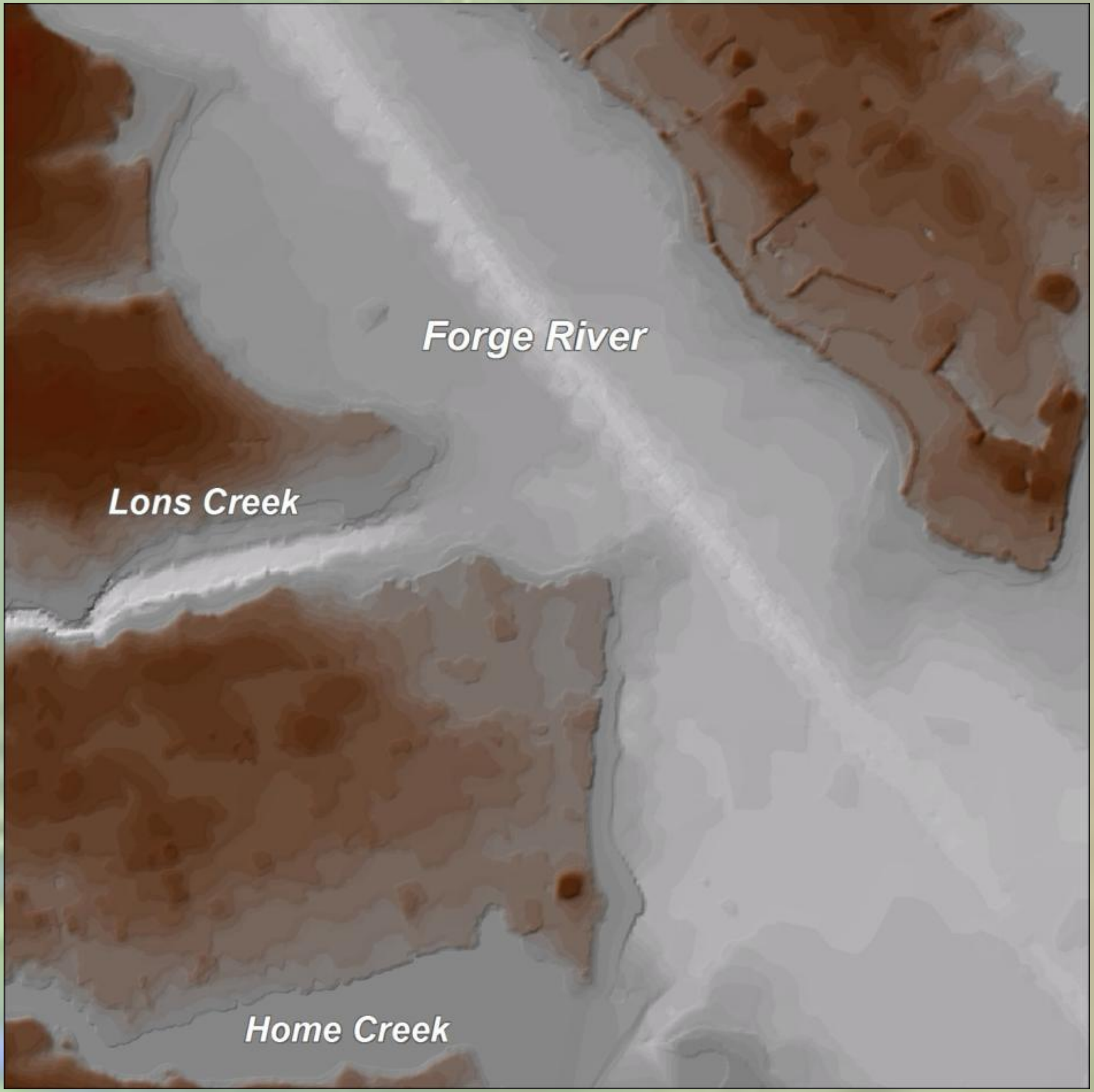
Topography & Bathymetry

Lower - Middle
Forge River



Topography & Bathymetry

Lower Forge River



Tidal Exchange – Moriches Inlet

- Located 0.9 nautical miles southeast of Tuthill Point
- 1200 feet wide
- Completed in 1933, jetty added 1947
- Several other bay breaches since
- Affect on Moriches Bay tidal range
  - 1940-1950 inlet shoaling: MB tidal range 0.7 - 0.2 feet
  - 1954 inlet reopened: MB tidal flow increased 20%
  - 1958 inlet deepened: MB tidal range 0.6 feet.
- Little Pikes Inlet: with inlet open MB tidal range increased 0.7 feet

Tidal Exchange - Circulation

- Mean tidal range
  - Atlantic Ocean at Moriches Inlet: 3.6 feet
  - Bay side of Moriches Inlet: 2.9 feet
  - Moriches Bay: 2.16 feet (1989-1990)
  - Forge River : 1.83 feet
- Sills restrict creek circulation
  - Mouths of Wills, Poospatuck, Lons and Home Creeks
  - Mouth of Old Neck Creek

Tidal Exchange - Circulation

- June-August 2007 sampling by SoMAS
- River mouth:
  - Mean surface salinity: 32.4-20.3 psu;
  - Mean bottom salinity 1.0 psu greater than surface
  - Temperature difference surface to bottom: 0.2ºC
- Brookhaven Town Pier
  - Mean surface salinity: 24.25-8.23 psu;
  - Mean bottom salinity 4.0 psu greater than surface
  - Temperature difference surface to bottom: <1ºC
- North of LIRR
  - Non-uniform freshwater discharge due to sill around channel
  - Mean surface salinity: 19.8-7.8 psu

Tidal Exchange – Water Column Circulation

- August 23, 2006 sampling by SoMAS
- Transect across FR north of Poospatuck Creek
  - Cold Moriches Bay water moves north with rising tide
  - Lower salinity water on east side
  - Lower DO content on west side (~1.5mg/L less)
  - Highest salinity in center of channel
- Transect across Wills Creek and FR main channel
  - Saline bottom water flows over sill into Creek; salinity vertically stratified past high tide – saline water trapped by sill
  - Poor exchange with main channel
  - Entire transect DO at 0mg/L at 0700 hr
  - Wills Creek bottom DO at 0mg/L and surface DO 7.5mg/L at 1400 hr

Tidal Exchange – Water Column Circulation

- Dredged creeks with sills (Wills Creek) create stagnant basins: high N groundwater trapped in creek: eutrophication/hypoxia
- Entrainment (ponding) of water north of LIRR due to deposits by trestle slows freshwater flow into FR
- Dredged channel exacerbates stratification, reducing mixing
- Wind mixes water
- Vertical mixing In shallow areas on the east (Ely Creek); oxygen rich surface water mixes with bottom water – less hypoxia
- Tree shading reduces photosynthesis/algal blooms

Water Quality

- Inorganics
- Organics
- Metals
- Dissolved Oxygen
- Nitrogen

Source: All water quality data provided by Suffolk County Health Department, Office of Marine Resources.

Water Quality – Inorganics

- 38 Stations
- 23 sampled frequently from 2005 through 2009
- 22 primary parameters including nutrients, dissolved oxygen, and bacteria
  - No DO exceedances at FRG019, FRG020, and FRG025
  - 10 stations had more than 25% DO exceedances
- 1 continuous probe located at mouth of Forge
  - 15-minute measurements of temperature, DO, salinity, and chlorophyll-a
  - DO exceedances up to 35% in one year

Water Quality – Organics

- Two events
  - June 5, 2006
  - December 21, 2006
- 4,484 total analyses
- 259 different analytes
- 22 stations
- Only 43 records exceeded minimum reporting limit (<1%) but not necessarily any WQ standards
  - Primarily naturally sulfur VOCs
  - Mainly stations FRG001, FRG002, FRG003, FRG004, FRG007, FRG0010
  - 39 were from June sampling event

Water Quality – Metals

- 19 Stations
- 1 event in June 2006
- Stations FRG015 – FRG028
- Monthly for spring-summer 2008 and 2009
- 33 parameters
- Numerous values below detection limits
  - No detects for key parameters such as arsenic, mercury, selenium

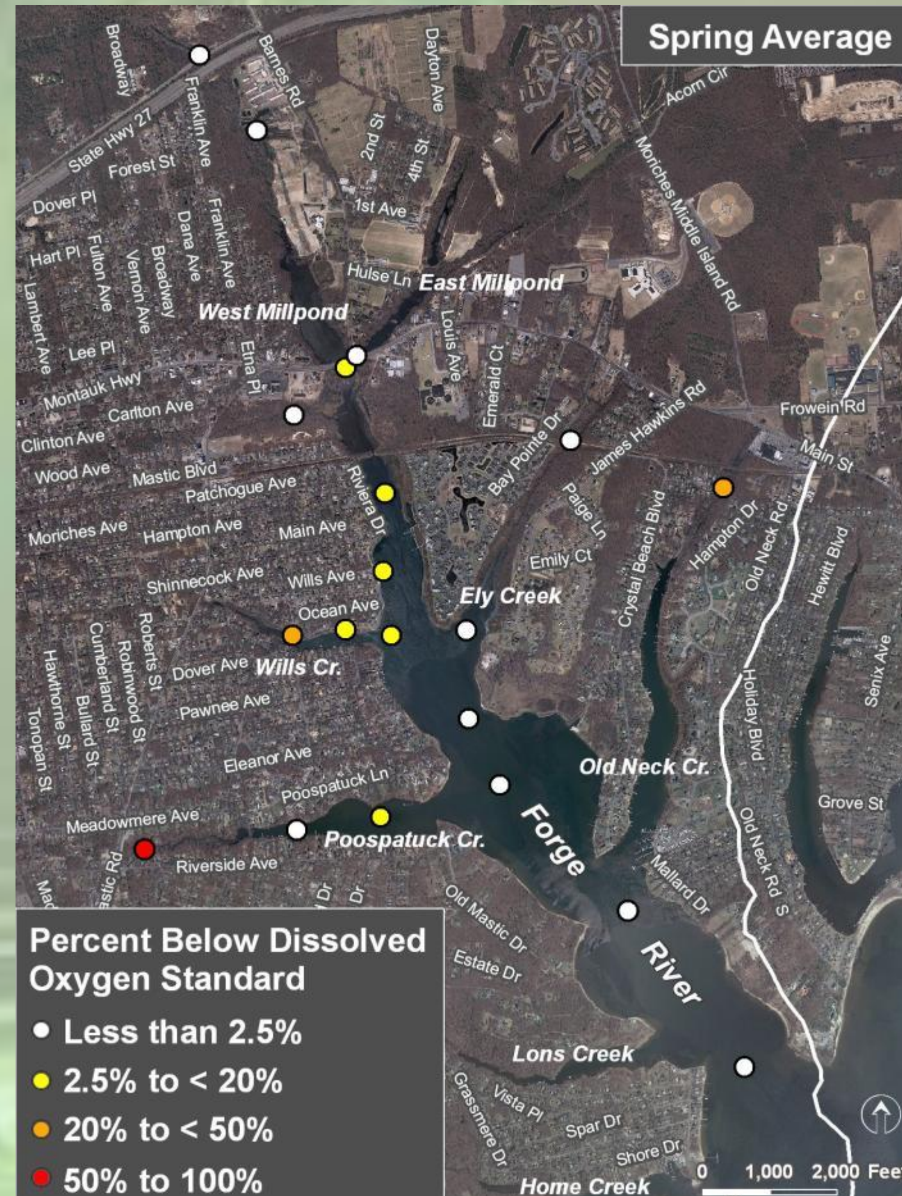
Water Quality – Dissolved Oxygen

- Temporal (daily and seasonal) changes
- Spatial distribution
- Relationship to nitrogen, algal blooms, and bacterial degradation

Dissolved Oxygen

Spring average DO

Percent of samples below 5mg/L standard

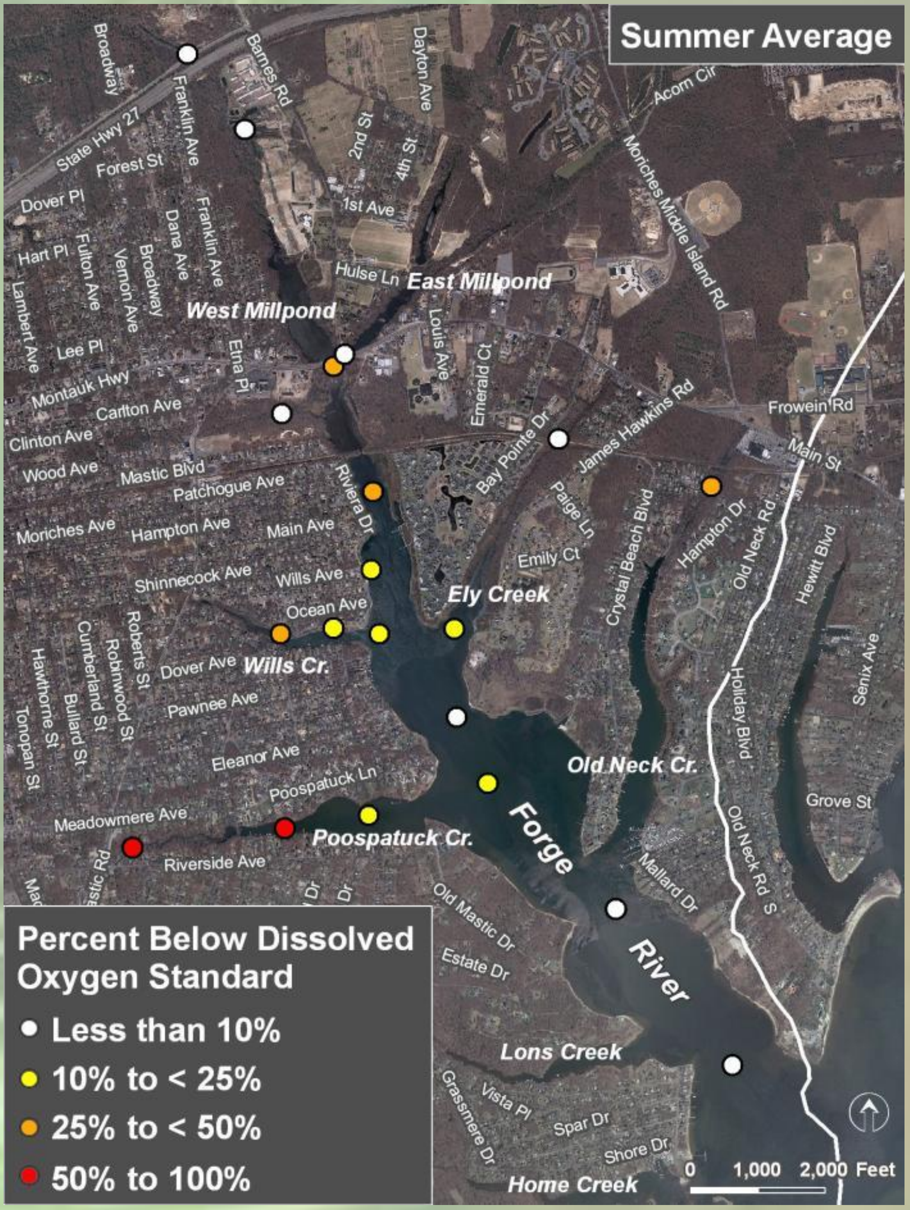


Source: Suffolk County Health Department.

Dissolved Oxygen

Summer average DO

Percent of samples below 5mg/L standard

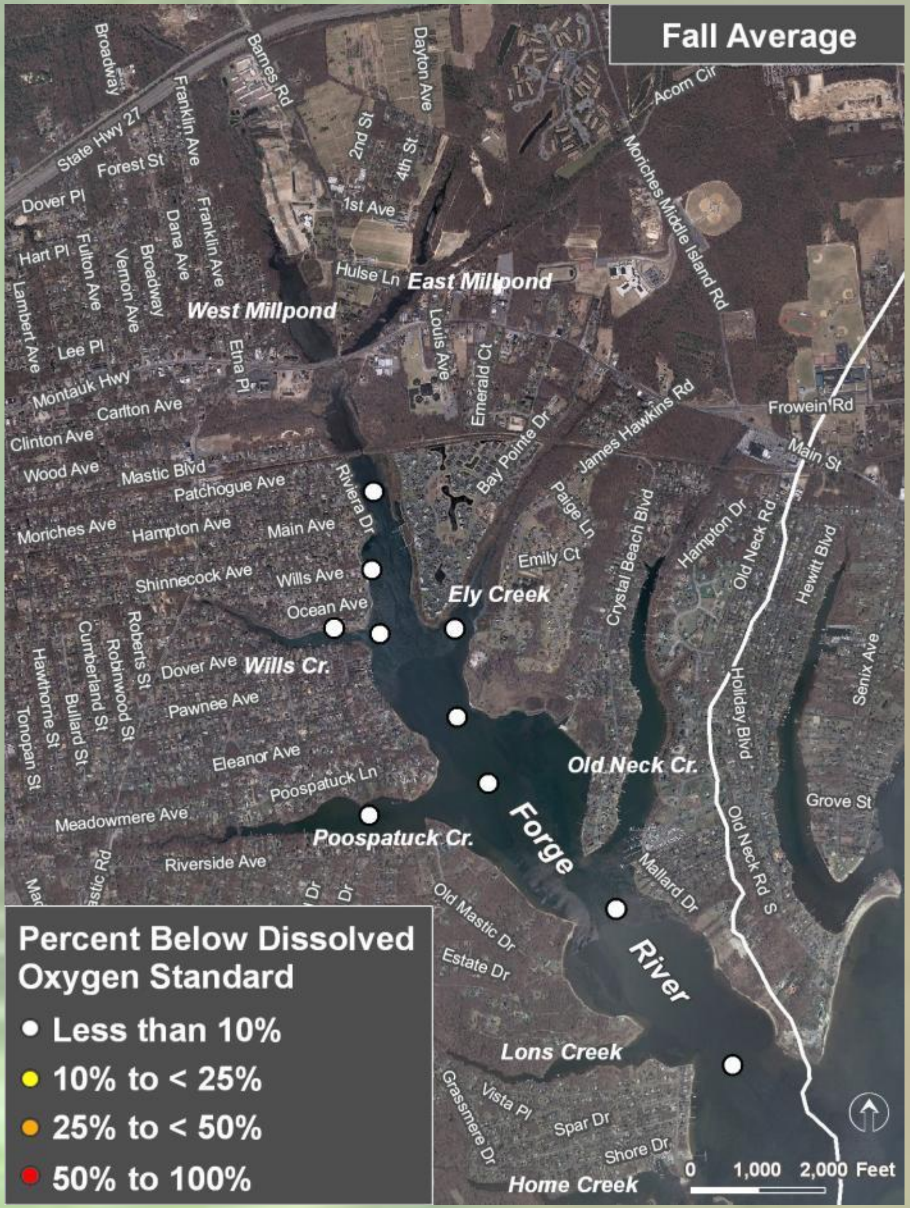


Source: Suffolk County Health Department.

Dissolved Oxygen

Fall average DO

Percent of samples below 5mg/L standard

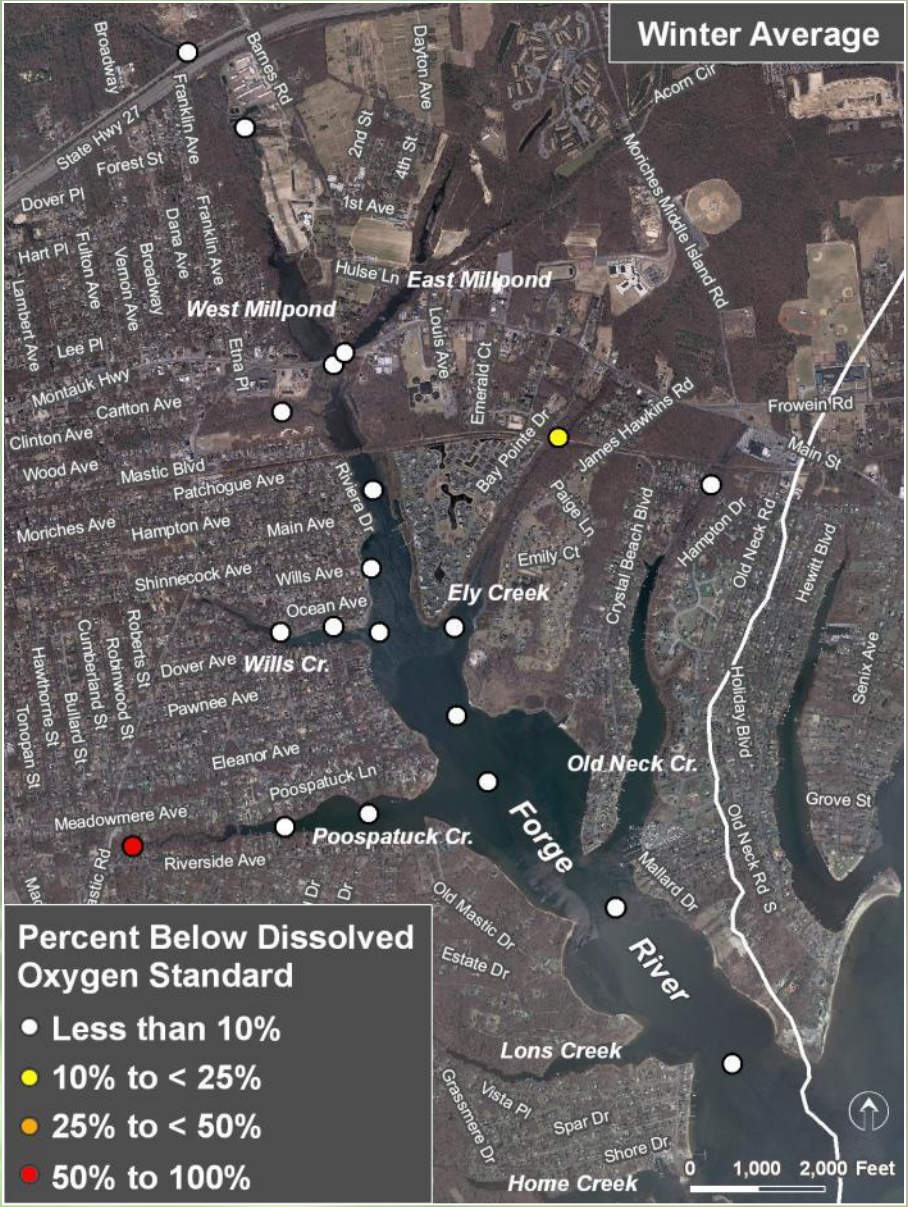


Source: Suffolk County Health Department.

Dissolved Oxygen

Winter average DO

Percent of samples below 5mg/L standard



Source: Suffolk County Health Department.

Water Quality – Nitrogen

- Inputs
- Temporal and spatial distribution
- Relationship to DO and chlorophyll-*a*
- Relationship to algal blooms and bacterial degradation

Water Quality – Nitrogen Inputs

- Stormwater runoff
  - Fertilizers from residential and commercial lawns
  - Other
- Groundwater
  - Residential and commercial wastewater
- Agricultural
  - General agriculture
  - Duck farm
- Atmospheric deposition
- Sediment release to water column

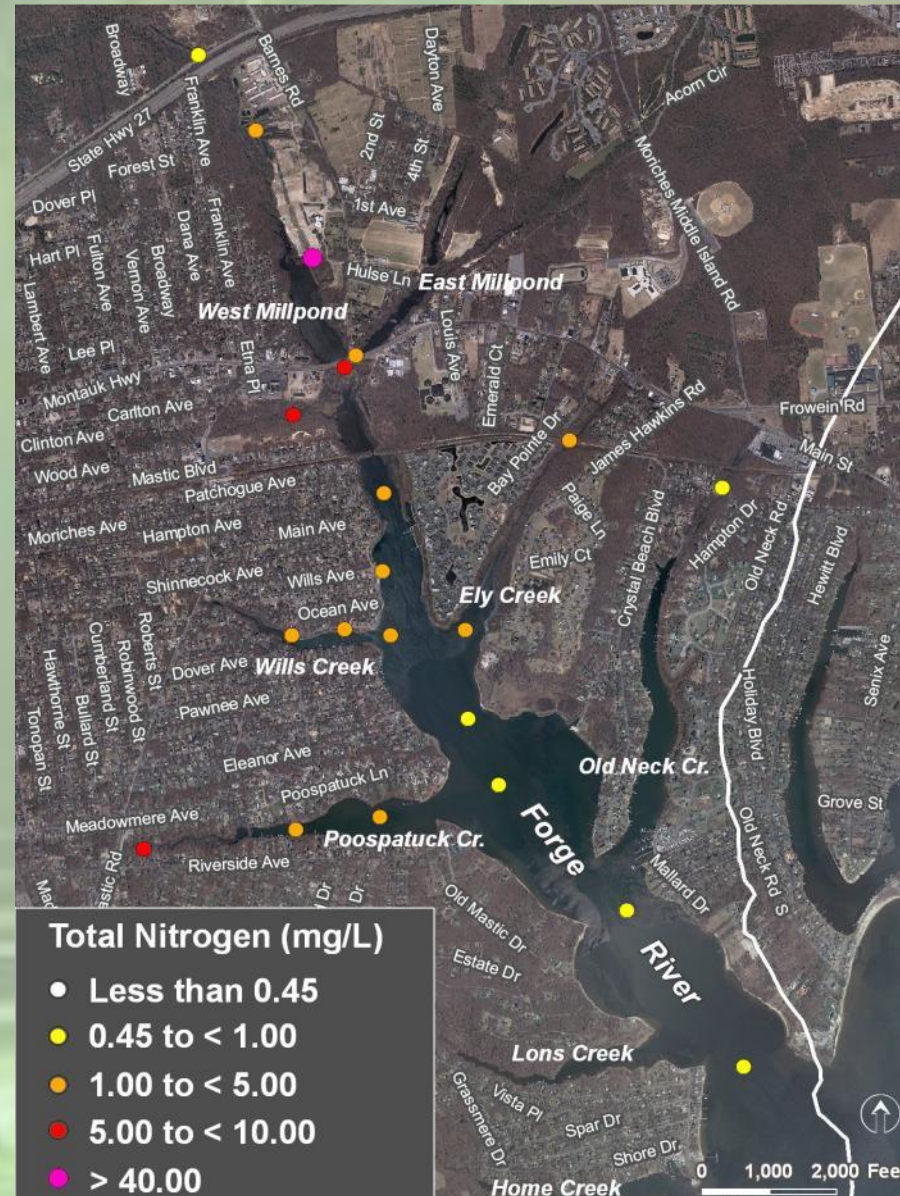
Nitrogen Inputs - Stormwater

- Stormwater nitrogen inputs are low (Swanson *et al* [2009] estimated <3%)
- Stormwater is major contributor of *Coliform* bacteria
- Stormwater can also deliver trash, other contaminants
- Stormwater treatment implementation possible

Total Nitrogen

Average of All Measurements

Inverse relationship with salinity - nitrogen concentrations decrease north to south in FR



Source: Suffolk County Health Department.

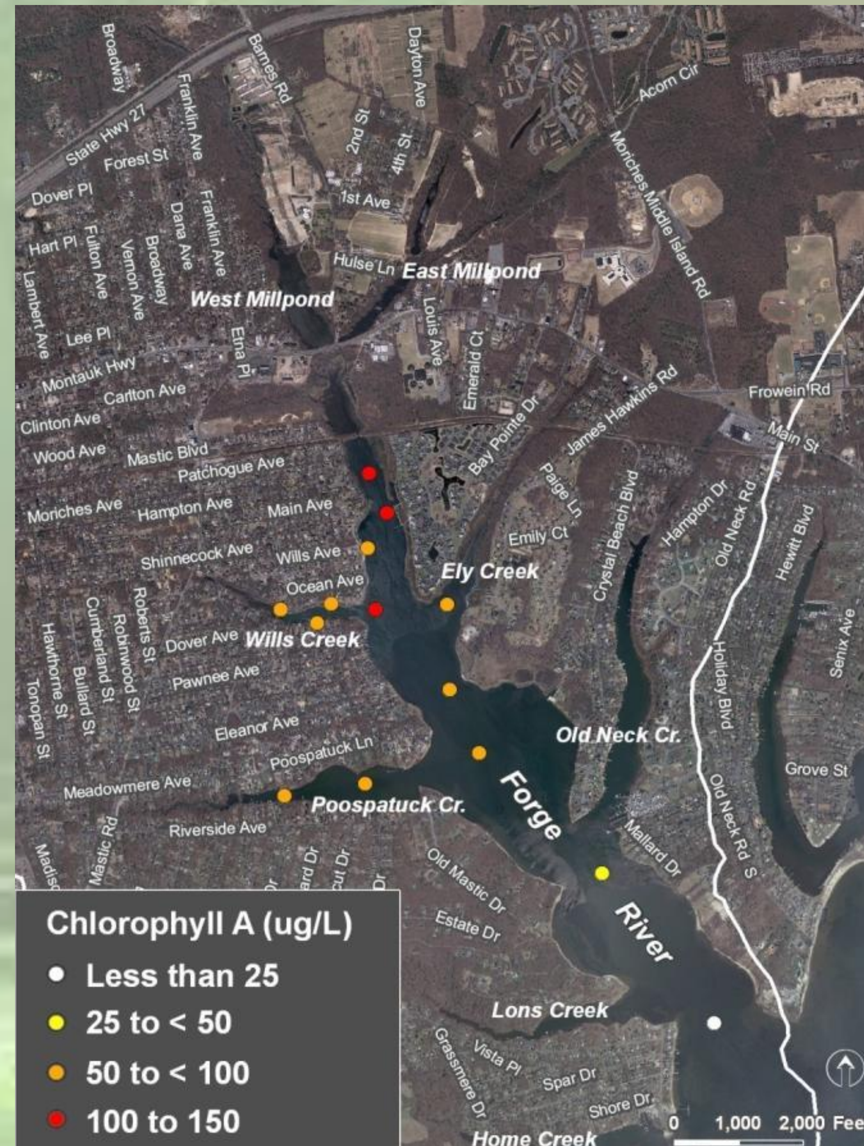
Nitrogen Inputs

Preliminary Nitrogen budget for land-based sources

Source: Project Team in association with SUNY SOMAS

	Existing Amount of Nitrogen (lbs/day)	Percent of Total	Build-Out Amount of Nitrogen (lbs/day)	Percent of Total
Fertilizer				
Agricultural	9.8	1.2%	1.0	0.1%
Residential	64.9	7.9%	89.9	9.1%
Commercial	2.4	0.3%	2.43	0.2%
Fertilizer Total	**77.11**	**9.4%**	**93.4**	**9.4%**
Precipitation Total	**91.0**	**11.1%**	**91.0**	**9.2%**
On-site Wastewater				
Commercial/Industrial	44.6	5.5%	143.1	14.5%
Residential	385.3	47.1%	443.2	44.8%
On-site Wastewater Total	**429.9**	**52.6%**	**586.3**	**59.2%**
WWTP Effluents				
JURGIELEWICZ DUCK FARM	195.0	23.9%	195.0	19.7%
WATERWAYS AT BAY POINTE PROPERTY	7.5	0.9%	7.5	0.8%
THE VILLAS AT PINE HILLS	13.2	1.6%	13.2	1.3%
PINE HILLS SOUTH	3.8	0.5%	3.8	0.4%
WWTP Total	**219.6**	**26.9%**	**219.6**	**22.2%**
Total Input	**817.6**	**100.0%**	**990.2**	**100.0%**
Internal Recycling	**Nitrogen (lbs/day)**	**Percent of Input**	**Nitrogen (lbs/day)**	**Percent of Input**
Benthic Flux	1,743.0	213.2%	1,743.0	176.0%

Chlorophyll *a* Distribution



Source: Suffolk County Health Department.

Water Quality – Nitrogen, Algae, Bacteria

- Nitrogen from GW, surface water, sediments
  - Stimulates growth of microscopic algae, *Ulva* (sea lettuce)
- *Ulva* in spring
  - *Ulva* bloom dies
  - Bacterial degradation uses DO, releases N back to water column
- Algae (phytoplankton) in summer
  - Daytime photosynthesis leads to supersaturated DO
  - Nighttime respiration and bacterial degradation DO goes to zero
- Chlorophyll-*a*
  - 7 times greater in FR than MB (WHOI, 1956-1959)
  - Summer blooms early-mid-July; fall blooms Oct and Nov

Sediments

- Description
- History
- Nitrogen and Carbon
- Metals
- Pesticides, PCB’s

- Except where indicated, information from Brownawell *et.al* (2009)

Sediments

- Summer 2006 sampling by SoMAS
  - Primarily in deeper formerly dredged channels (accessible)
- Depth to sand layer 2.3 to 9.2 feet, most >7.9 feet
- Sediment color/texture transition at <u>0.5-2.0 feet</u>
  - Above: soupy, dark brown-black, much less consolidated
  - Below: gray to light brown, more consolidated
  - Represents <u>depth of last major dredging</u> (1965-1972)
  - <u>No DDT or PCB residues below transition</u>, sediments below transition are older than 1950's.
- No detritus in sediments (except in East Pond)
  - Sediment organic matter from algal growth, not upstream

Sediments

- Total Organic Carbon (TOC)
  - "Incredibly" high at 7.7-12.1% vs. 7% in highly sewage impacted, eutrophied, sluggish Jamaica Bay
  - Extremely high algal production due to nitrogen loading
  - High TOC in East Pond from leaf litter
- Total Organic Nitrogen
  - Highly elevated TOC remineralized by bacteria serve as nutrients for additional algal production

Sediments

- Higher metals content
  - Enriched due to high TOC and fine grain size – higher adsorption of metals
  - High sulfide content means scavenging of certain metals: explains high content of Mo, Cd, possibly Cu, Ag, Zn, Pb
  - Mo and Cd high relative to other estuaries (not from anthropogenic sources)
- PAH's
  - Likely from combustion sources and atmospheric deposition
  - Within range of other urbanized estuaries, but over background

Sediments

- Pesticides and PCB’s
  - DDT concentrations (DDD, DDE) low, except East Pond
  - Maxima correspond to historical use: banned in 1972
  - Virtually no other pesticides above detection limits
  - Low concentrations of PCB’s suggests atmospheric sources

Living Resources and Key Habitats

- Organisms[1]
- Key Habitats[2]

[1] Field sampling information as summarized by Swanson *et.al* (2009)

[2] Field observations by the Team

Living Resources - Organisms

- Numerous fish and crab kills
- Bottom devoid of macrofauna
- Dinoflagellates dominate most sites
- Diatoms dominate freshwater sites (Ponds)
- Potentially harmful (shellfish) dinoflagellates in summer
  - *Prorocentrum minimum, P. micans, Akashiwo sanguinea*
- *Ulva lactuca* (sea lettuce) important in nutrient cycling
  - Growth peaks in southern sites in April
  - Dies > 25 ºC and when light penetration declines from blooms
  - Decaying *Ulva* releases nutrients, consumes oxygen, contributes to summer phytoplankton blooms

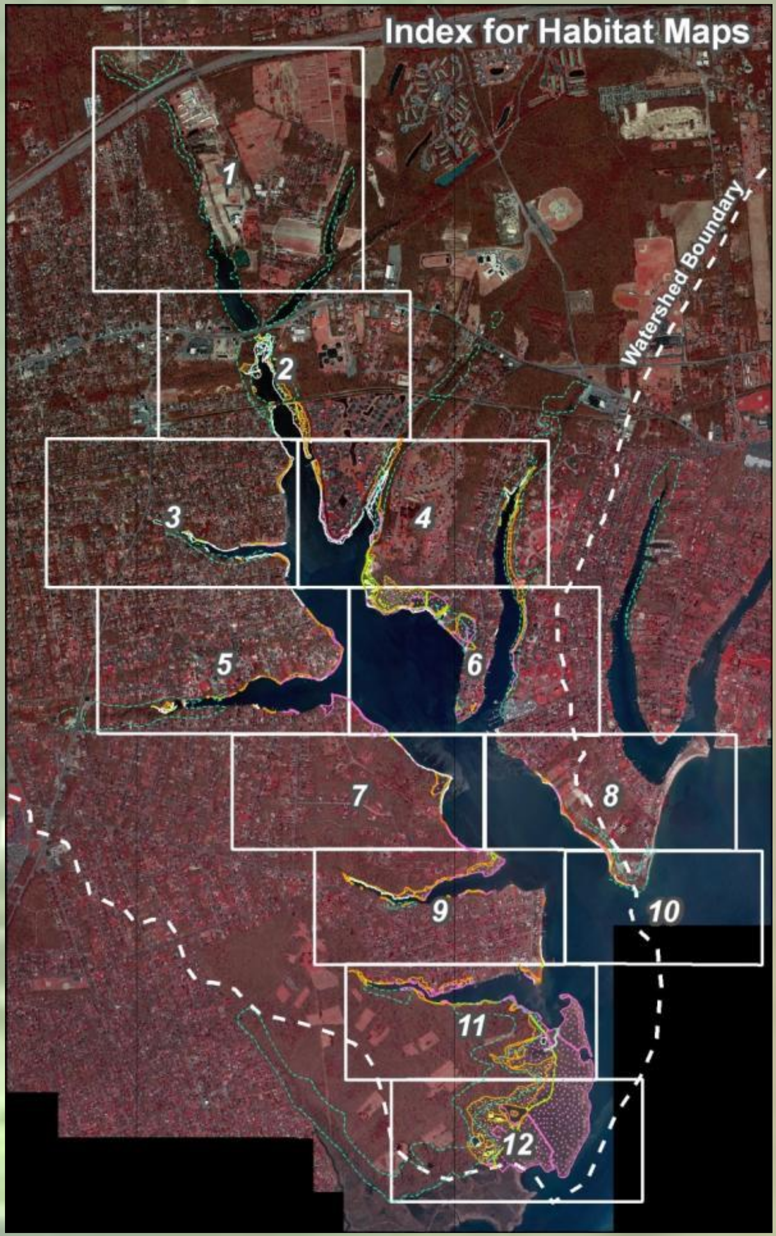
Living Resources – Key Habitats

- Freshwater ponds
  - East and West Mill Ponds eutrophic
  - West Pond adjacent to apparently healthy freshwater marsh
  - Both ponds surrounded by dense tree cover
  - East Pond covered with algal mats and duckweed
- Brackish water zone
  - Montauk highway to railroad trestle
  - Reduced salinities, extensive *Phragmites* stands
  - Important for Mill Ponds nutrient removal
- Mudflats
  - Extensive flats in Ely Creek, Old Neck Creek
  - Highly unconsolidated sediments, little, if any benthic life

Living Resources
Key Habitats

Coastal habitat mapping by Team completed for majority of the Forge River

Source: Photo interpretation and field survey by project team.



Living Resources – Key Habitats

- Tidal Wetlands
  - Swanson (2009): 33.1 acres of wetlands (64% between Poospatuck and Lons Creeks, 20% north of Wills Creek)
  - *Spartina* marshes along the east side of the Forge River
  - Very little tidal marsh in Wills Creek
  - Constructed marsh along Poospatuck; Healthy tidal marshes at heads of Poospatuck and Lons Creek
  - Extensive *Spartina* in Home Creek; along William Floyd estate
  - High marsh areas limited
- Creek heads
  - Dumping, trash and invasive plant growth in areas upland of several Creek heads

Impairments

- Nitrogen inputs
  - Stimulates algal blooms, decreases oxygen, adds organic load
  - On-site wastewater systems
    - Very poor treatment in cesspools
    - Large number of on-site systems too close to groundwater
  - Duck farms
    - Very poor treatment
  - Nutrient-rich sediments
    - Little bacterial degradation due to low oxygen
    - Flux back into water column
  - Stormwater
    - Residential and agricultural fertilizer use
    - Minor contribution, but fixes available

Impairments

- Degraded shoreline
  - Bulkheading
  - Abundance of *Phragmites,* limited *Spartina* marsh
  - Extensive mudflats, few hard/sandy bottoms
- Circulation and Tidal Exchange
  - Poor horizontal circulation
    - Impeded by sills across Creeks and mouth of FR
    - Channels in Creeks and FR reduce horizontal movement
    - Shoaling by LIRR trestle restricts flow in/out of brackish area
  - Poor vertical mixing
    - Dredging created basins in Creeks with little mixing
  - Tidal exchange in FR reduced by shallow channel to Intercoastal

Watershed Management and TMDL (Total Maximum Daily Load) Planning

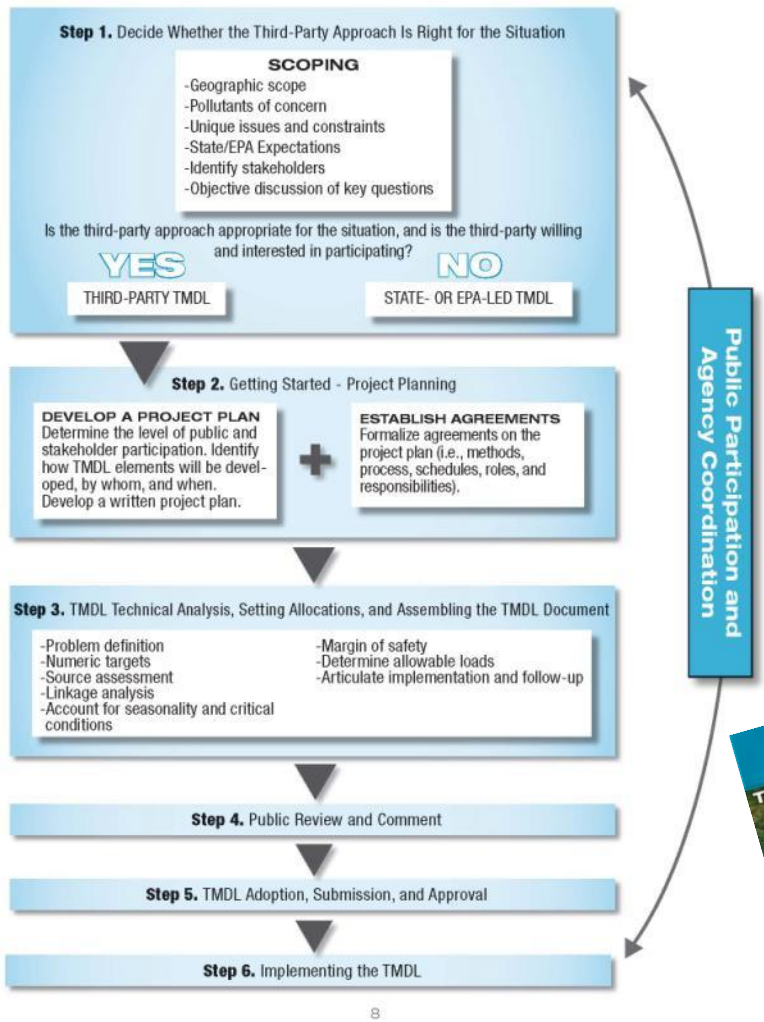


Figure 1. Third-Party TMDL Development Process

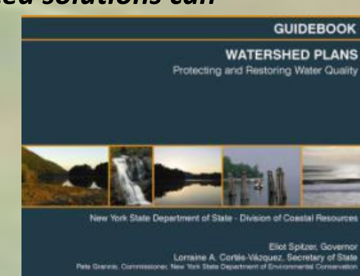
The Clean Water Act designated TMDLs as the mechanism to achieve fishable-swimmable goals.

TMDL = Σ WLAs + Σ LAs + MOS
- WLA = Waste Load Allocation
- LA = Load Allocation
- MOS = Margin of Safety

TMDLs were envisioned and originally focused on controlling point sources.

TMDLs are implemented in New York via permit limits on discharges (SPDES) and other regulatory mechanisms that are enforceable.

A comprehensive watershed management plan with a number of coordinated solutions can achieve your goals



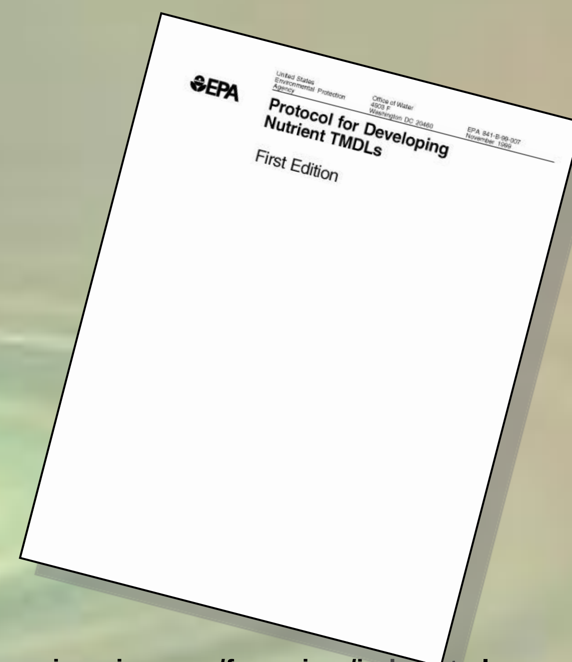
www.cameronengineering.com/forgeriver/index.html

Pollutant Load Limit

- Identify and implement actions to achieve eliminate use impairments
- Water quality standards are the primary performance measure
- A preliminary nutrient balance will provide the framework to identify solutions and guide additional work
  - Point sources, non-point sources
  - Estuarine conditions
  - Other

Steps in Calculating Nutrient TMDLs

- ❑ Problem identification
- ❑ Identification of water quality indicators and targets
- ❑ Source assessment
- ❑ Linkage between water quality targets and sources
- ❑ Allocations
- ❑ Follow-up monitoring and evaluation
- ❑ Assembling the TMDL


EPA
United States Environmental Protection Agency
Office of Water 4503 F Washington DC 20460
EPA 841-B-99-007 November 1999
Protocol for Developing Nutrient TMDLs
First Edition

Nitrogen TMDL RFP

- Initial steps implemented by this project
- Nitrogen TMDL Work Will Require
  - Continuing public outreach
  - Developing detailed watershed, groundwater, and receiving water models
  - Performing modeling analyses to simulate solutions compared to performance measures
  - Allocation analyses

Mitigation Concepts for Consideration

Multiple Solutions over Short, Mid, and Long Term

- Suite of concepts
  - Actions by homeowners and Town
  - Additional data collection
  - Pilot projects to test technologies
- Major actions
  - OWTS upgrading management
  - Duck farm fix
  - Dredging
  - Sewering
- Phasing
  - Short, mid, long term

Mitigation Concepts – Short Term

Water Quality Overlay District – Consider Zoning Overlay

- Consider FR Water Quality Overlay District (OD)
  - Coordinate with Town’s Carmans River OD in development.
  - Develop priority list of parcels in the OD for acquisition.
  - Consider a Town Waterways Preservation (TDR) Credit program to allow transference of density out of the watershed.
  - Establish performance criteria to assure health of estuary.
- Support NYSDEC efforts to have duck farm meet DEC effluent limits or close it
- Town to consider acquisition of duck farm

Mitigation Concepts – Short Term

Water Quality Overlay District – Data Collection

- Conduct GIS-based inventory of all On-Site Wastewater Treatment (OWTS) Systems in Overlay District (OD)
  - Include: location, type, capacity, installation date
  - Include: complaints, service type and dates
- Map groundwater elevations in OD
  - Install additional GW monitoring wells in key locations
  - Develop detailed GW elevation map for OD
- Overlay OWTS locations on GW map
  - Determine locations of ‘critical’ OWTS based on depth to GW and type of system

Mitigation Concepts – Short Term

Water Quality Overlay District – Data Collection

- Sample GW wells for nitrates along transects to Creeks
- Determine horizontal degradation of N in groundwater
- If significant denitrification occurs or can occur in GW
  - Consider setting N standards for developments and OWTS replacements based on distance from surface water

Mitigation Concepts – Short Term

Water Quality Overlay District – Flow Reduction

- Increased residence time in OWTS improves N removal
  - Encourage (or require) dual flush toilets for all new or bathroom remodels inside OD
  - Encourage (or require) use of low flow faucets for all new or bathroom and kitchen remodels inside OD
  - Encourage (or require) washing machine effluent directed to shallow subsurface recharge structure for all new construction or remodels inside OD

Mitigation Concepts – Short Term

Water Quality Overlay District – Restrict Fertilizer Use

- Restrict use of fertilizer inside the OD
  - Limit (or prohibit) residential fertilizer use
  - Limit agricultural use
  - Limit (or prohibit) commercial landscape fertilizer use
  - Eliminate municipal fertilizer use

Mitigation Concepts – Short Term

Water Quality Overlay District – Evaluate OWTS District

- Onsite system upgrades and replacements
  - Cesspools common before mid 1970s
  - Cesspool N removal significantly lower than septic systems
  - Cesspools should be replaced by septic systems
  - Septic systems require maintenance, eventual replacement
  - Onsite systems should meet current County requirements
  - Upgrading/replacing onsite systems is costly

Mitigation Concepts – Short Term

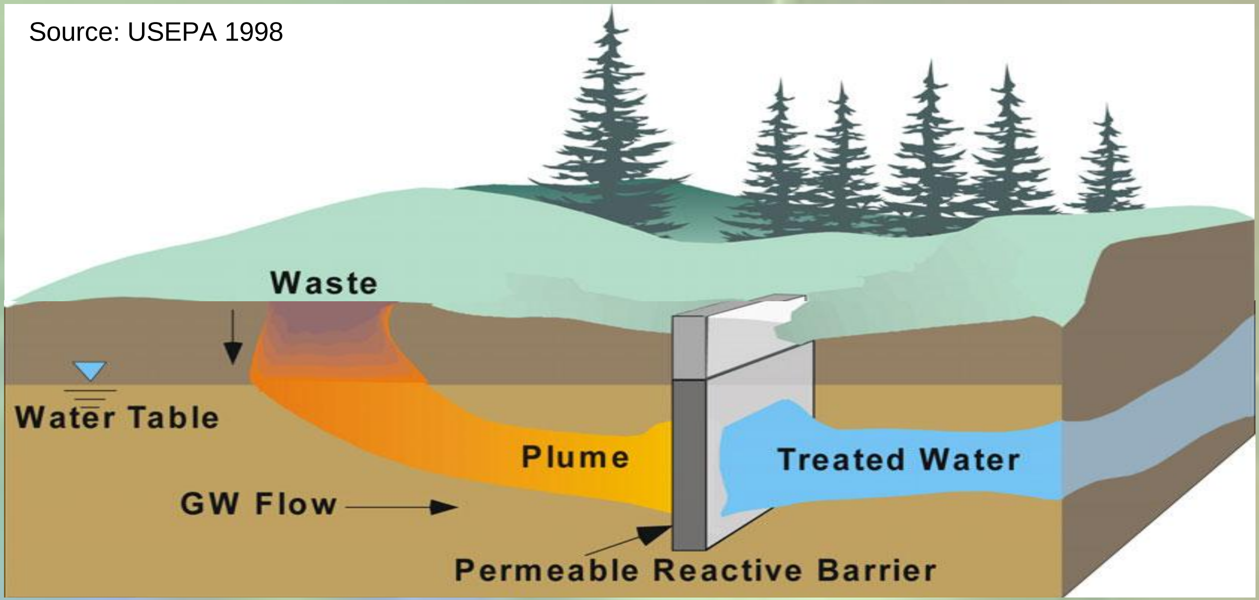
Shellfish Cultivation to Reduce Algal Blooms

- Test cultivation of filter-feeding oysters
  - Raft culture off docks
  - Evaluate growth and survival
- Cultivation in uncertified waters problematic
  - If successful, transfer for grow-out elsewhere possible

Mitigation Concepts – Short to Mid Term

Water Quality Overlay District – Evaluate PRBs

- Conduct pilot study of Permeable Reactive Barriers (PRBs)
  - Intercepts high-nitrate groundwater before it enters surface waters.
  - PRBs use trench filled with sand and degradable carbon source (e.g., sawdust, newspaper, etc.)
  - As plumes pass through low-oxygen, carbon-rich barrier, bacteria break down nitrate to nitrogen gas, reducing nitrogen to estuary.



Mitigation Concepts – Short to Mid Term

Water Quality OD – Evaluate Biological Augmentation

- Conduct pilot studies to test biological augmentation
  - Direct injection of proprietary bacteria into properly functioning OWTSs.
  - Injection of proprietary bacteria (and carbon source) into GW between homes and surface water.
  - Consider evaluation in conjunction with PRBs

Mitigation Concepts – Short & Long Term

Increase Dissolved Oxygen to Reduce Odors

- Short-Term - Test aeration without dredging
  - Increased DO *will not* remove nitrogen
  - Increased DO *can* reduce hydrogen sulfide and odors
  - Off-bottom bubblers good and surface aerators better
  - Multiple units needed for Creek length
  - Consider solar-powered units
  - Avoid boating conflicts
- Long-Term - Test aeration after dredging
  - Removal of Creek dredged material could increase efficacy of aeration

Mitigation Concepts – Mid to Long Term

Water Quality OD – Increase Riparian Buffer

- Develop constructed wetland program
  - Construct wetlands along some Creek edges as buffer
  - Incentivize Creek-side homeowners to have wetlands restored
- Acquire Creek head properties
  - Construct ‘natural’ upland/wetland stormwater treatment systems

Mitigation Concepts – Mid to Long Term

Water Quality Overlay District – Remove Biomass

- Vegetation takes up nitrogen, but returns it as it dies
  - Consider harvesting Ulva (sea lettuce) in Spring
  - Consider harvesting *Phragmites* before flowering

Mitigation Concepts – Mid to Long Term

Water Quality OD – Dredging and Capping

- Short-term dredging
  - Remove sills from Creek mouths to improve circulation
  - Insure circulation through length of Creeks (remove barriers)
  - Remove sill at mouth of FR
- Mid-Term dredging
  - Remove/cap accumulated sediments in West Pond
- Long-term dredging and sediment management
  - Remove/cap accumulated sediments in Creeks
  - Fill selected Creek basins with sand
  - Remove muck from main channel of FR
  - Connect mouth of Forge River to intercoastal channel
  - Operate dredged material management site

Mitigation Concepts – Mid to Long Term

Wastewater Collection and Treatment – Selected Areas

- Sewering all of FR contributing area very expensive, but may ultimately be necessary – need results of TMDL work
- Results of pilot studies
  - Does/can distance from surface water reduce N input to FR?
  - Can biological augmentation reduce N input to FR?
  - Does a permeable reactive barrier reduce N input to FR?
- OWTS management for those that meet or can meet County requirements (including distance above GW)
- Collection and community treatment systems for low-lying areas
  - Collection from septic tanks to community treatment system or
  - Abandon OWTSs and direct to community treatment system
  - Several small treatment systems
- Sewage treatment for entire contributing area may be necessary depending on results of pilot studies and TMDL analyses
- Septage Management District

THANK YOU
Questions?

Extras for Discussion

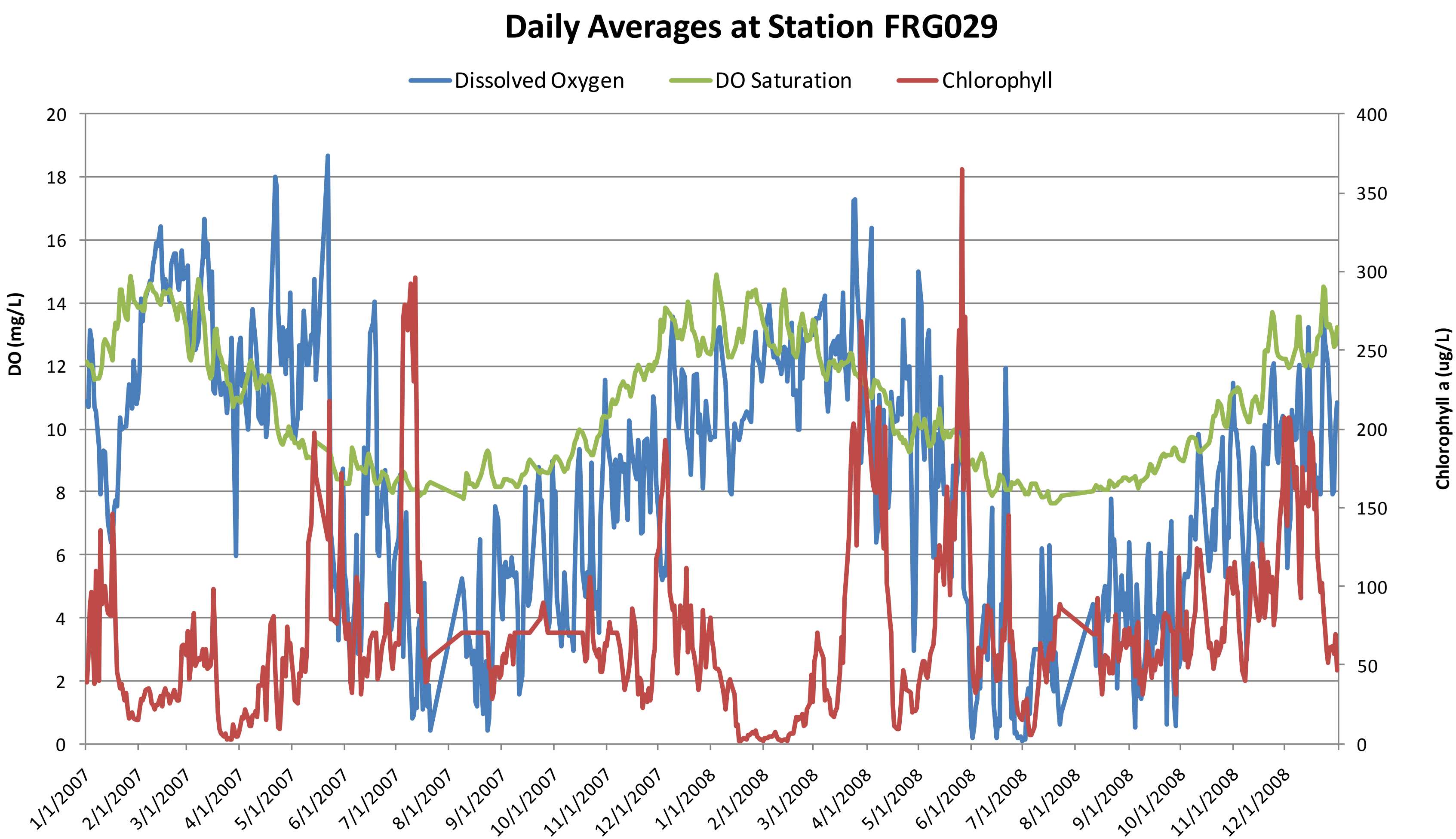
Nitrogen Inputs

Nitrogen budget by Swanson *et.al* (2009)

Note: West Pond input includes duck farms and assumes tertiary treatment of duck farm wastes – not currently in place

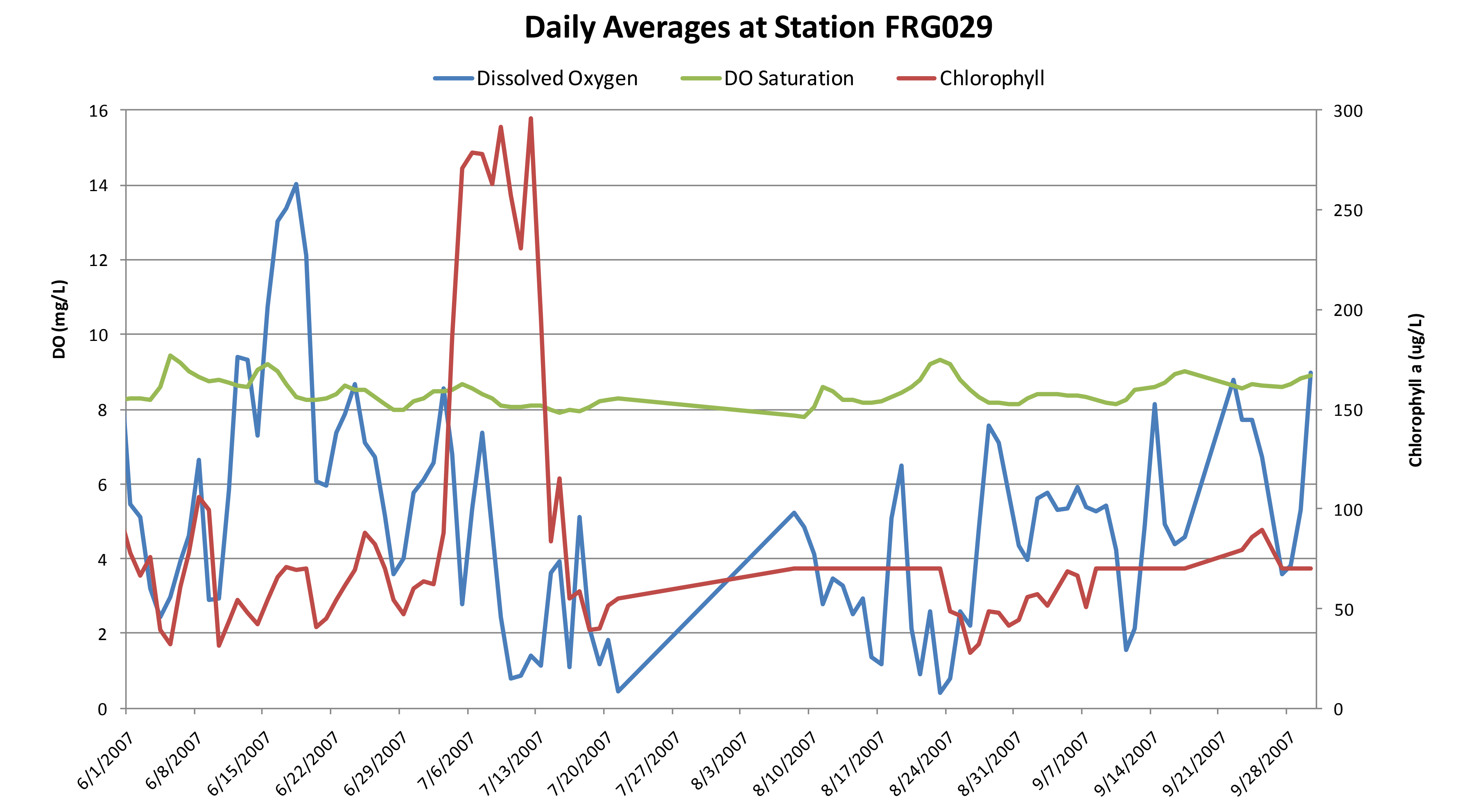
Inputs	mol N/Yr	Percent of Input
Poospatuck Creek	127,000	0.7%
Wills Creek	11,300	0.1%
Swift Creek	728,000	3.7%
Ely Creek	30,000	0.2%
Old Neck Creek	323	0.0%
East Pond	280,000	1.4%
West Pond	3,060,000	15.7%
Total tributaries	**4,240,000**	**21.7%**
Atmospheric Deposition	**501,000**	**2.6%**
Stormwater Runoff	**424,000**	**2.2%**
Groundwater	**14,300,000**	**73.3%**
Total Input	**19,500,000**	**100.0%**
Internal Recycling	**mol N/Yr**	**Percent of Input**
Benthic flux from	8,760,000	45%
to	17,500,000	90%
Ulva Remineralization	358,000	1.8%
Exports	**mol N/Yr**	**Percent of Input**
Burial	2,720,000	14%
Tidal Flushing	15,400,000	78%

Water Quality – 2007-2008 DO and Chl *a*



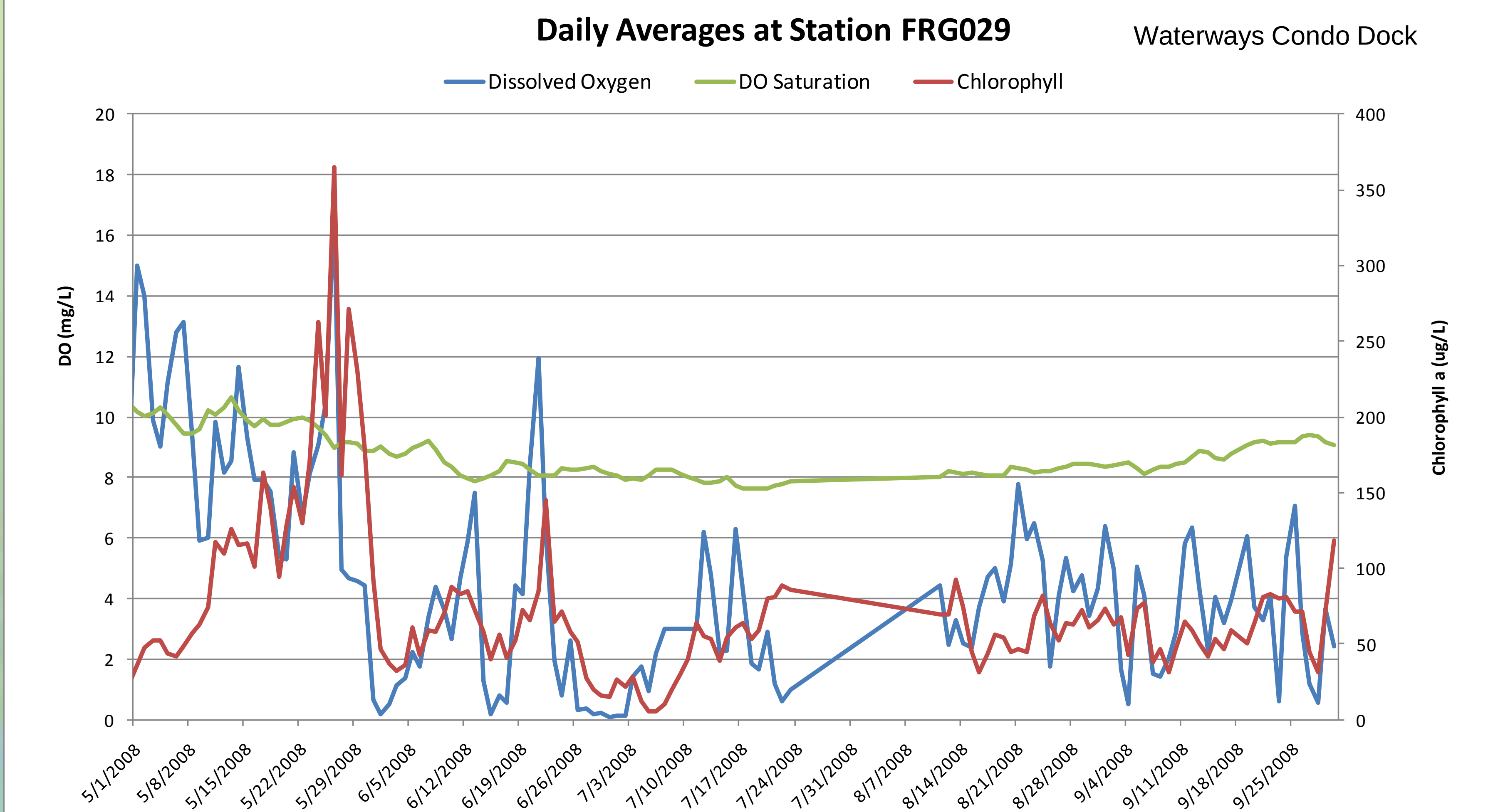
Source: Suffolk County Health Department.

Water Quality – 2007 Summer DO & Chl *a*



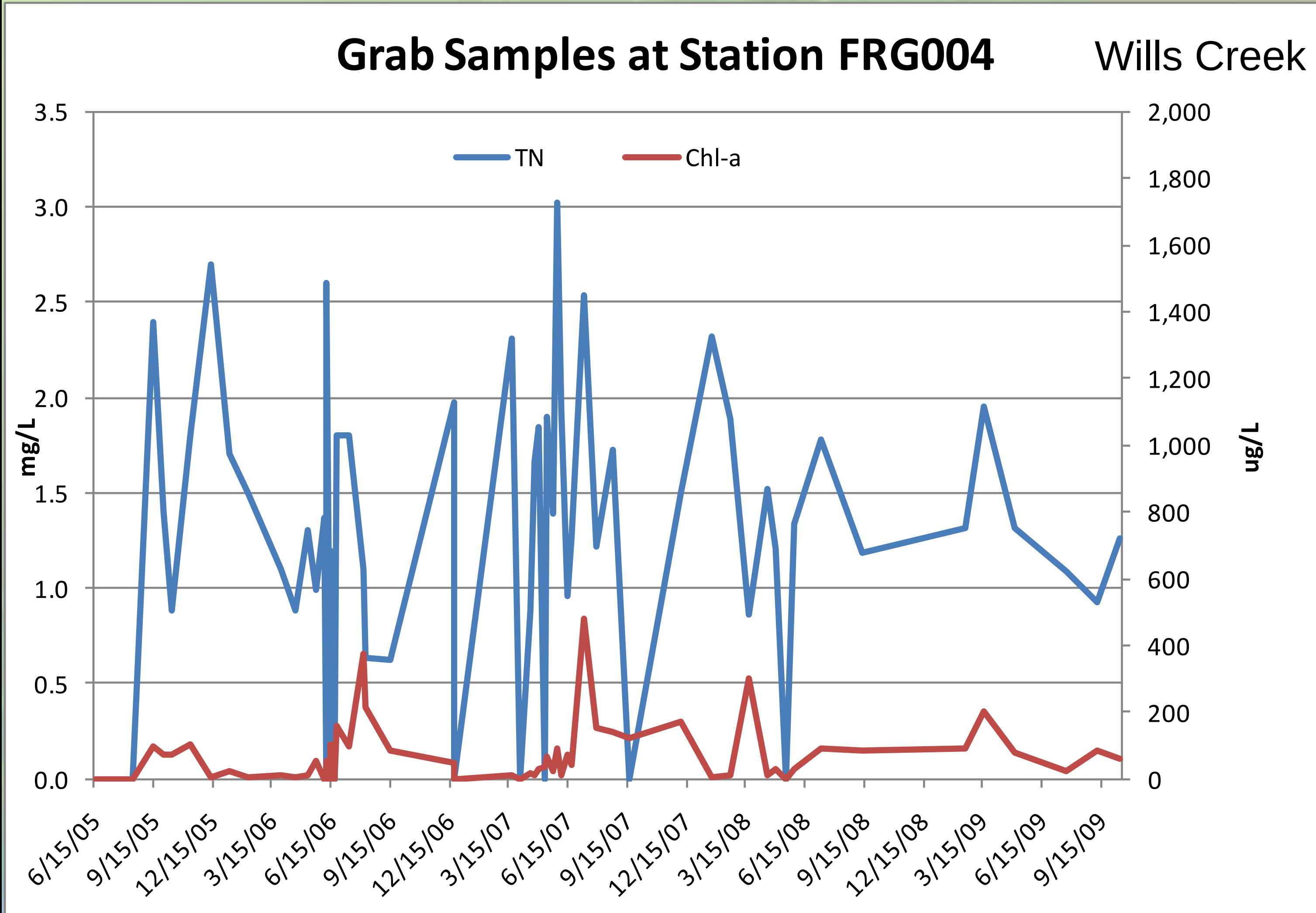
Source: Suffolk County Health Department.

Water Quality – 2008 Summer DO & Chl *a*



Source: Suffolk County Health Department.

Water Quality – 2005-2009 N & Chl *a*



Source: Suffolk County Health Department.

Living Resources - Key Habitats

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